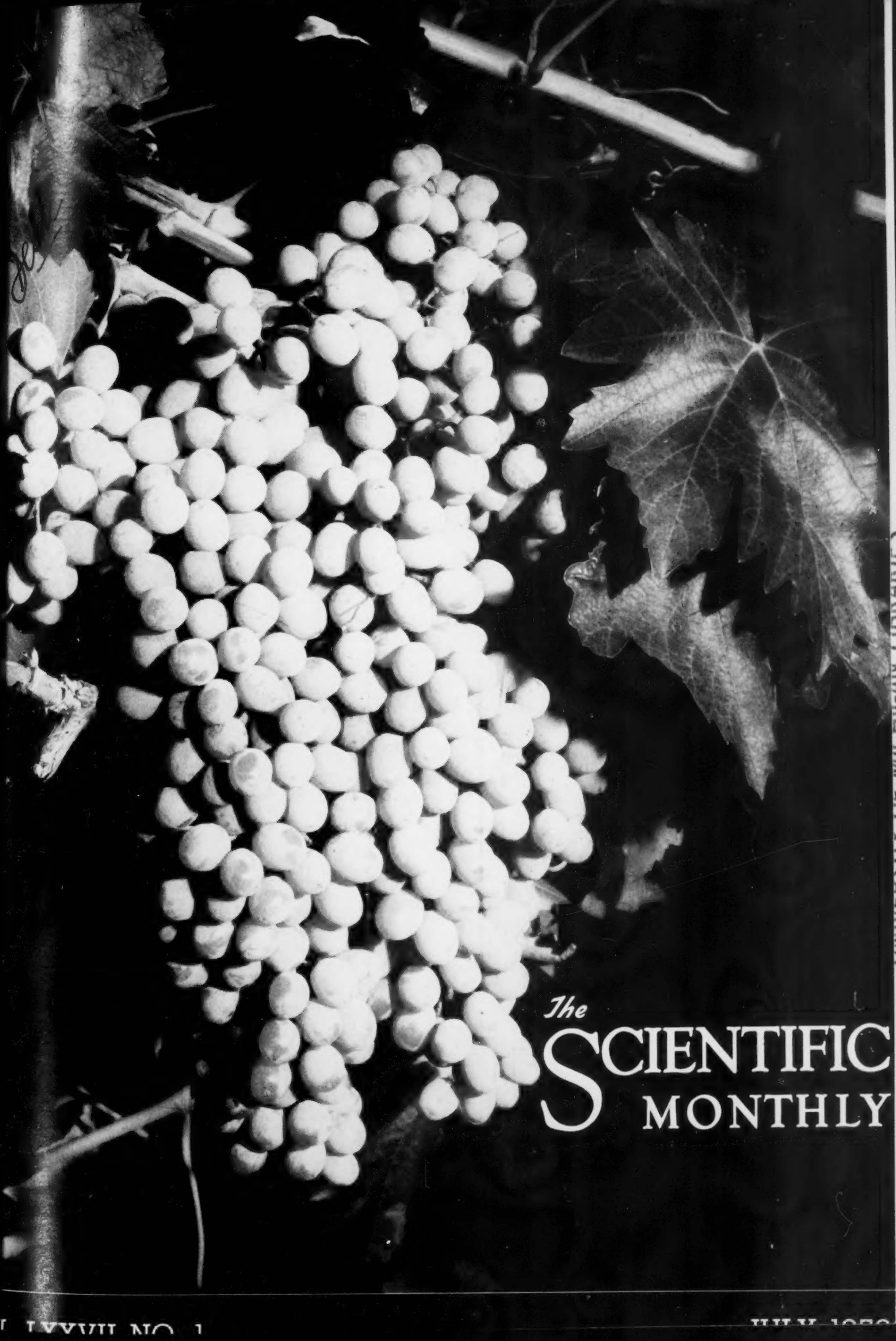

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Contents

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Science and Technology

(From the Month's News Releases)

Furnace Vacuum

A furnace-cleaning machine works like a powerful vacuum cleaner and removes ash, scale, and soot from industrial furnaces and boilers to improve efficiency. Accessories include attachments for cleaning flues, air ducts, and chimneys. The machine has a 115-volt a.c.-d.c. motor, weighs 43 lb., stands 32.5 in. tall, is 21.25 in. wide and has a tank diameter of 17 in.

Hand Cleaner

A novel hand cleaner looks like a cold cream when first applied but rapidly turns into a liquid. Especially good for mechanics, painters, and home hobbyists, the cleaner penetrates crevices of the skin and dissolves grease and grime. Hands are rubbed briskly, then wiped clean with a cloth or paper towel. No water is needed, but can be used.

Midget Moisture Meter

The Midget Moisture Meter is a direct-reading electronic instrument providing rapid, accurate indications of the moisture content of lumber, wood, and wood products before, during, and after fabrication. All readings are made directly in percentage of moisture and complete test takes but a few seconds. The use of the meter in mills, factories, and lumber yards increases kiln production, facilitates matching of stock before fabrication, bonding or gluing, and eliminates rejections caused by warpage, case hardening, or splitting. Painters use it to tell whether surfaces are safe to paint, whether there are any hidden wet spots in the weather board or siding caused by moist insulation behind the boards. The meter also rapidly indicates whether plaster is sufficiently dry for painting.

Heavy-Duty Cleaner

A heavy-duty cleaner for wet or dry pickup in industrial, commercial, or school floor maintenance is now available. The unit has a 1-h.p., 115-volt, a.c.-d.c. motor with permanently lubricated ball-bearings. It produces a vacuum equivalent to 58 in. average maximum water lift. The container, finished in durable, baked-on metallic gray, has a liquid capacity of 13 gal., and a dry capacity of 1.25 bu. Filtering area is 1060 sq. in. Ball-bearing swivel casters have soft rubber tread for ease of operation and maximum floor protection. A protector fuse prevents liquids from damaging the motor when the unit is used for wet pickup. Tank dimensions are: height, 35½ in.; diameter, 20½ in. Weight is 68 lb.

Included with the cleaner is a set of cleaning tools for general maintenance, including a rubber-lined hose and adapter, steel floor rod, aluminum floor nozzle, utility tool, and slide-on brush. A wet-pickup tool kit, including a rubber-bladed squeegee, steel-bladed squeegee, and suds shield, is available at slight extra cost.

Corrosion and Tarnish Control

Rust-controlling oil, formerly available only to industry, now can be bought in convenient household sizes. It combats corrosion and tarnish stains on brass, copper, and automobile chrome. Rust action is stopped when the oil is applied to steel sashes, screens, hardware, garden tools, and metal furniture.

Octagonal

New eight-sided mothballs resemble tiny doughnuts. The new design permits them to be strung like beads on clothes hangers. It also keeps them from rolling under beds and dressers when dropped. The "mothballs" are said to be more efficient than spherical ones because of their extra surface for vaporization.

On Stage

Any room can become a theater, convention hall, or ballroom with little effort through the use of a folding stage. This completely portable unit is constructed from select fir. The wood floor will not sag or sway because it is mounted on a sturdy steel understructure. The stages are available in standard heights of 15 and 24 in., and in standard widths of 6, 8, 10, 12, 14, and 16 ft. Each of these sizes can be obtained with from 1 to 19 folding sections. Each section is 22 in. wide and folds into a space 3½ in. deep. For special problems, special sizes are available.

Malathion Spray

Aphids and mites, those tiny garden pests scarcely visible to the naked eye, can be controlled quickly and safely with a new spray. This spray is based on malathion, a new chemical insect killer. Big advantage of the new material is that it kills both aphids and mites without being especially hazardous to people, animals, or plants. Recommendations range from 1 to 2½ teaspoonfuls per gallon of spray, depending on the type of infestation and the plant being treated. It is recommended for use on most flowers and ornamentals, evergreens, apples, grapes, pears, and most vegetables.

Year-round Thermostat

A year-round thermostat has been designed for use with the combination heating and air-conditioning plants which many manufacturers are placing on the residential market. Instead of separate thermostats and separate wiring for heating and cooling controls, the thermostat has a switch position marked "Cool," which maintains desired cooling temperature in hot weather just as the "Heat" position of the switch controls warmth in winter. The model not only eliminates the extra thermostat but also reduces installation costs with a single four-wire low-voltage thermostat cable.

THE

SCIENTIFIC MONTHLY

JULY 1953

Alaska: Progress and Problems*

ERNEST GRUENING

Dr. Gruening was governor of Alaska from 1939 to 1953. He was born in New York City and received both his B.A. and M.D. degrees from Harvard University. In 1933 President Roosevelt appointed him general adviser to the U.S. delegation at the Pan American Conference in Montevideo. He was director of the Division of Territories and Island Possessions of the Department of the Interior 1934–1939 and commander-in-chief of the Alaska National Guard 1942–1947. He has been a member of the Board of Governors of the Arctic Institute of North America since 1948. Dr. Gruening has also been the editor of various newspapers and magazines and wrote Mexico and Its Heritage *(1928) and* The Public Pays *(1931).*

IT IS difficult to dissociate a discussion of Alaska's progress and problems from its previous history. Perhaps the word "progress" should be defined first, because there may be divergent views about what constitutes progress.

There was, and perhaps still is, a school of thought in the United States that believed the best use of Alaska was to keep it a wilderness area and lock up its resources indefinitely, reserving them for use in some far-distant future. There is still another that, concerned with the preservation of a particular resource, fears the advancing march of modernity and would hold it in check to safeguard that resource at any price. There was until very recently a school of thought in the Office of Indian Affairs that believed it desirable to preserve aboriginal custom and manners unchanged, to try to enclose its human exemplars as hermetically as possible, and to insulate them from the penetration and contamination of the white man's civilization. Such ideas are perhaps entitled to respectful attention, but for the purpose of this discussion I shall try to outline my conception of progress for Alaska.

World population is increasing at an unprecedented rate. Many areas are overcrowded, and sparsely settled areas, if habitable, naturally invite settlement. Considerations of special importance relating to national defense call for the populating of Alaska and for the creation of conditions there that will tend to insure the permanence of such population. Apart from all this, the westward trek of peoples, in search of greater freedom and greater economic opportunity, is undoubtedly the oldest American tradition. It is a tradition that antedated the founding of our republic and indeed was inseparably connected with its origins. It brought the Jamestown colonists, the Pilgrims, the Dutch, and the great variety of European emigrants across the Atlantic in the seventeenth and eighteenth centuries. It led them to cross the Appalachians toward the close of the eighteenth century. It carried them across the plains, over the Rockies and to the

* Based on an address presented at a general session of the Third Alaskan Science Conference, Mt. McKinley National Park, September 22–27, 1952, sponsored by the Alaska Division of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Pacific coast in the nineteenth century. It is bringing them to Alaska *now* in the middle of the twentieth century. This contemporary westward migration of Americans to Alaska is in a sense a final chapter in a great episode. This chapter gives new vitality and meaning to the phrase long used to describe Alaska, "the last frontier."

If we accept this interpretation of what is now taking place, it follows naturally that, to whatever extent immigration to Alaska has been achieved, it may be considered progress, particularly if the evidence indicates that the settlement is probably permanent. So we may set down the following as the first item under the head of progress: The population of Alaska *is* increasing very rapidly, and the increase has aspects of greater permanence than previous migrations.

The first Alaska census, taken in 1880, showed a population of 33,426. The next census, 1890, showed the population to be 32,052. This slight decrease need not be considered significant, as it is known that the first census in 1880, taken under great difficulties, was not too reliable. But certain it is that in the ninth decade of the nineteenth century, when the population of the United States increased by over 12,000,000, the population of Alaska did not increase. The census of 1900, reflecting the great gold rush, showed a population of 63,592, or an increase of almost 100 per cent. This impulse carried over to 1910, with the gold strikes in the Tanana Valley, the Iditarod, and Nome following those in the Klondike. The somewhat temporary nature of this influx, coinciding with the diminishing productivity of the gold fields, was reflected in the drop in population to 55,036 in 1920. World War I certainly contributed to that decrease because there was little in the way of economic opportunity in Alaska to induce the young men who had gone to war to return to Alaska. The increase in the third decade to 59,278, or some 7 per cent, indicated no great change. Actually, if Alaska's population figures for the first three decades of this century are contrasted with those of the United States, it will be plain that Alaska, viewed politically, economically, and socially, was static and stagnant. In those same thirty years the population of the United States increased by 45,000,000. But in Alaska there was a decrease, from 1900 to 1930, of 4314, or over 6 per cent. The accidental discovery of gold that brought a rush of prospectors to Alaska at the turn of the century had doubled the population, and by and large that figure was retained for the next thirty years. But throughout that first third of this century Alaska experienced none of the normal growth, either through excess of births over deaths or through immigration, which was characteristic of the United States as a whole, and which was particularly related to the westward movement of population.

In Alaska the real change began in the 1930's. The 1940 census showed that Alaska's population had reached 72,524. This was an all-time high for Alaska; it showed an increase of 22.3 per cent, a percentage of increase in the preceding decade that was exceeded in that same decade by only two states in the Union. Thus Alaska in the fourth decade of this century—from 1930 to 1940—showed a percentage of increase greater than that shown by forty-six states. The Alaskan increase of 22.3 per cent contrasted with a 7.2 per cent increase for the United States as a whole.

In the fifth decade, however, the increase and the acceleration were even greater. The 1950 census showed a population of 128,643, or approximately 77 per cent in the last decade, an increase greater, percentagewise, than that of any state or territory, and a population which had more than doubled in 20 years. Today Alaska's population may be conservatively estimated at over 165,000, and its increase is not only continuing but continuing at an accelerating rate. We may conservatively forecast a population of 200,000 in 1955, and of 300,000 in 1960. The really important aspect of this growth is that it contains many elements of permanence formerly lacking. Until recently, until this present growth got under way, Alaska differed substantially from the previous frontiers in American history. Whereas the westward march from the Atlantic to the Pacific contained a large proportion of would-be settlers, individuals who hoped to establish themselves permanently in new surroundings, no such purpose actuated the overwhelming majority of those who came to Alaska from the time of the first population increase in the late 1890's until the early 1930's. They came rather as the Spanish and Portuguese came to Central and South America, not to take up permanent residence in the New World but to get gold and take it back with them to the mother country. Obviously, with that motivation there could be no permanence but only transience. Desire to improve the environment was lacking, and the resulting lack of improvements perpetuated the transience. It was a kind of vicious cycle. Those who came to get rich quickly—if possible—and get out found little here to make permanent residence attractive, and, their intentions being what they were, they did little to make the environment better. This, of course, was by no means true of a small minority who stayed on, but by and large

the pattern was set by those whose stay was purposefully temporary. This attitude was reflected in the relative inaction of successive territorial legislatures. And the Federal Government continued its course of indifference and lack of interest.

What, then, are the factors that have contributed to this population increase and to its presumed permanence? The answer lies in part in a fundamental change in Federal attitude which has been reflected in Federal policy and action. An important motivation for this change may be found in international events. In the first three decades only two significant *Federal* actions contributed to Alaska's development. One was the construction of the Alaska Railroad, begun in 1915 by the Wilson administration and completed in 1924. The second was the establishment of a land-grant college—the Alaska Agricultural College and School of Mines, authorized in 1915 and opened in 1922, which in 1935 became the University of Alaska.

In the 1930's there were several such actions. First was the increase in September, 1933, of the price of gold from $20.67 to $35 an ounce. This gave Alaska's second industry, mining, a great lift, which continued for the rest of that decade. Second was the Matanuska colonization project in 1935, which brought 200 families into the Valley, gave agriculture in Alaska an impetus, and widely publicized Alaska as an area of potential settlement. Third was the extension of social security to Alaska in 1937 by action of the Alaska legislature after a request from the Federal authorities.

In the 1940's international events and the Federal actions resulting therefrom stimulated population growth. Preparations for defense, totally lacking previously, brought in thousands of construction workers and G.I.'s. Not a few of the G.I.'s settled in Alaska at the end of hostilities.

The defense program for World War II brought the first major airports and radio range stations to Alaska. They made possible commercial air service between the States and Alaska, which was initiated in 1940 and amplified in 1945 by certification of additional carriers and additional routes by the Civil Aeronautics Board.

The defense program also brought the Alaska Highway in 1942 (although a highway over a different route had been recommended three years earlier by an American commission), and the Glenn Highway and with it the beginnings of a territorial highway system.

The World War II defense program established three permanent bases in Alaska (not counting the Aleutians) whose existence has benefited the economies of their areas: Fort Richardson near Anchorage, Ladd Field near Fairbanks, the naval station at Kodiak. It established a scattering of CAA stations throughout Alaska. It made a Coast Guard District of Alaska.

These were the material contributions incidental to defense when hostilities ended in 1945. They were substantial. They aided the economy of Alaska, created some permanent and needed improvements, and established a great new interest in Alaska in the States as a new frontier of promise and opportunity. The last contribution was of great importance.

The years since 1945 have seen a great amplification and intensification of the process. The "Cold War" and defensive preparations to avert a third world war have brought extensive housing, the first highway program in Alaska in the interior (though not in southeastern Alaska), great airports at Anchorage and Fairbanks; a public works program on a fifty-fifty matching basis which is helping to provide schools and utilities for our towns; the beginnings of an electrification program by the United States Reclamation Service at Eklutna; a program of agricultural research; a new interest in the mining of strategic minerals; the erection of the Geophysical Institute at the University of Alaska.

No less significant, however, have been the territorial changes in attitude and performance. The Territory was becoming conscious of its responsibilities and its destiny. It established a full-time health program in 1945; a territorial housing authority; a territorial Department of Agriculture; a development board. In 1946 it passed a Veterans' Act under which several thousand Alaska veterans were loaned funds to buy or build homes or to acquire farms or businesses.

In 1949 the legislature established a territorial Department of Fisheries. It set up a Department of Aviation, and under it, with funds from aviation gasoline and some Federal matching, brought about the construction or improvement of a hundred airports and seaplane facilities. In 1951 the legislature enacted legislation to promote the tourist industry on a fifty-fifty matching basis with private subscriptions. A most constructive step was also taken in banning billboard advertising.

Most significant of all was the enactment in 1949 of a comprehensive revenue program. Previously taxes had been negligible, and whole categories of businesses and individuals deriving substantial profits and income from Alaska had paid no taxes whatever. The result was that the revenues were insufficient to support essential public services. Great wealth was extracted from the Territory, but next to none stayed here for its development. That

has now been fully remedied by an inclusive yet moderate tax structure. The Territory will not only balance its budget at the end of this biennium but will also emerge with a surplus of several million dollars. The Territory has no indebtedness. By being financially strong and sound, it is able, and will increasingly be able, to render the services—schooling, health, welfare—which the American people properly expect as part of their way of life.

So far the record of progress relates chiefly to governmental action, Federal and territorial. But private industry is coming to Alaska. In this very year the first pulp plant in Alaska is under construction near Ketchikan to utilize the long-unutilized forests; a plywood mill is under way at Juneau; the Aluminum Company of America is making gigantic plans for processing at Dyea; extensive private oil drilling is scheduled for the coming season in the Katalla-Yakataga area; new tin and coal mines have been opened—all undertakings of private capital, which is entitled to every legitimate encouragement and assistance, particularly since so large a part of Alaska's economy has been, and will for some time continue to be, based on government spending.

These, then, are some of the factors that account for Alaska's recent and accelerating growth and progress.

At this point the above rather limited identification of *progress* with *growth of population* should be supplemented by suggesting the goal to which that progress is or should be directed. This goal, in the process of its attainment, predicates a highly important role for Alaska. Given its unique geographical position—its location in far northern latitudes, its fronting on the Arctic Ocean, its extension into the Eastern Hemisphere, its juxtaposition to the Soviet imperialism—all characteristics which no other area under our flag possesses, Alaska's destiny must be envisioned and shaped on the cosmic scale to which its great size, position, and potentialities invite our national enterprise.

In short, the destiny of Alaska is to be not merely militarily a bulwark of defense (and, if necessary, of offense) for this continent—and hence for the free world—the strategic assignment Billy Mitchell so brilliantly forecast, but, concomitantly, a no less vital outpost for the American idea and therefore a living demonstration of all that is best in an American society. That is a major role in national and world affairs, but it requires no great imagination to appreciate its desirability and value. It is a challenge only to our powers of performance.

To date, the cultures of only two peoples have established themselves permanently this far north. They are the Scandinavians (and Finns), who have erected a high civilization and a stable economy in these latitudes and whose concepts of freedom are similar to ours; and they are the Russians who, under the present rulers in the Kremlin, have established at our doors a militant society whose concepts are antithetical to ours and menace freedom wherever it may be found or hoped for on earth. Therefore the *national* stake in the attainment of Alaska's destiny is emphasized here, and the suggestion is made that it be constantly borne in mind as we discuss Alaska's problems.

The most essential step toward this major objective is statehood. This is not the place for a detailed presentation of the cogent arguments for it, but here are a few salient points:

1) The people of Alaska asked for statehood in a referendum six years ago.

2) Public opinion in the United States overwhelmingly supports statehood for Alaska.

3) Every Congressional committee to which the issue has been referred has, after study, reported favorably upon it.

4) No arguments have been advanced against statehood which are not in essence identical with those presented against the admission of states previously admitted.

5) The minority opposition in Alaska has dwindled almost wholly to contention about the statehood bill itself—introduced in the last Congress—with regard to whether it was generous enough.

6) The national interest will be greatly served by statehood and disserved by its continuing denial.

Statehood will go far to provide a solution, or at the very least will facilitate a solution, of many of Alaska's problems. All these problems are related directly or indirectly to the issue of continuing growth in population and of its permanence.

Among the most pressing are land problems. Alaska is a very sparsely settled part of the world. It has about one person for every $3\frac{1}{2}$ square miles, in contrast to the United States with about fifty per square mile. Among the obstacles to settlement are the Federal land laws. In general, these are the laws adopted decades ago for the forty-eight states. They are obsolete, inappropriate for Alaska, and to a degree unworkable. Poor as they are, their application is further handicapped by the failure of Congress to appropriate adequate funds for surveys, and likewise by red tape in their administration. This is a field in which Alaskans are estopped by law from helping themselves.

Over 99 per cent of Alaska is Federal land—either public domain controlled by the Department of the Interior, or reserved or withdrawn by some other

Chilkoot Barracks and Haines, Alaska. Terminus of a new road to the interior (U. S. Forest Service).

Federal department. The Organic Act for Alaska passed by Congress in 1912, likewise an obsolete and outworn instrument—against whose limitations of territorial autonomy every governor since its enactment has protested—leaves the business of basic land legislation in the hands of Congress. Congress has done little to improve the situation.

The first Alaska legislature created by the Organic Act, meeting in 1913, memorialized Congress on various basic issues which the Organic Act specifically forbade the territorial legislators to do anything about. Its memorials on the subject of land were fourfold. *One* asked that the land laws be revised and simplified to promote settlement. A *second* asked that an end be put to reservations and withdrawals, and that some of those already made be restored for public entry. A *third* asked that an end be put to shore-space reservations. A *fourth* dealt with still other aspects. Not only has Congress paid no heed, but the reservation and withdrawal policy has continued without let or hindrance so that today approximately one-fourth of Alaska, some 94,000,000 acres or 147,000 square miles, is in some form of withdrawal or other. This is an area larger than our third largest state, Montana. It is an area larger than the total areas of eleven smaller states—the six New England States and New Jersey, Delaware, Maryland, South Carolina, and West Virginia. This does not mean that some of these withdrawals have not been for a good purpose. But the withdrawal process has become so tangled, haphazard, and confused, with withdrawals overlapping and with their original purpose long since forgotten and invalid, that it has taken the Department of the Interior two years to find out what and where these withdrawals are. The question of returning such withdrawals, whose present use is not clearly essential, still lies ahead. A subcommittee of the House Committee on Interior and Insular Affairs is coming to Alaska this week to address itself particularly to the problems of the revision of our land laws. But experience has shown that there is often a long gap between Congressional investigation and favorable action.

What is needed is a thorough overhauling of our land laws relating to Alaska. Their objective should

be to promote settlement. One of the arguments repeatedly used by the Congressional opponents of statehood is that only a small fraction of land in Alaska has passed from Federal to private ownership. Yet Congress itself has held the keys and has persistently refused to unlock the door.

The statehood bill, which lost by a margin of one vote in the last Senate, would give the State of Alaska some 23,000,000 acres of land to be chosen by the authorities of the new state. Reserved land is, of course, excluded from this offer which would, nevertheless, give the State of Alaska an area as large as New England or, to put it in another way, give Alaska more land for its use or disposal than is now possessed by four public land states, namely, Arizona, Idaho, Utah, and Nevada which have, respectively, 19,327,927, 19,269,006, 14,803,363, and 8,894,920 acres not in public domain. The *percentage* of this proposed grant to the new state of Alaska is, of course, smaller than that given to the public land states, leaving some 93 per cent of Alaska's total area in public lands, as compared with Nevada's 87 per cent, Arizona's 73 per cent, Utah's 72 per cent, and Idaho's 67 per cent. But here the percentages are less important than the actual amount of land—the best unreserved land—the new state would receive.

But statehood is introduced here again in this discussion merely to point out its remedial benefits, which are probably not otherwise obtainable. The process of revision of the land laws—as distinct from the question of land grant to the new state—would be speeded by statehood to the extent that the addition of two senators and a representative with a vote would aid the process.

There is another aspect of land law revision which requires attention. Two important geographic areas are now in national forest reserves. They are the Tongass National Forest, which roughly coincides with all southeastern Alaska, an area of some 16,000,000 acres, and the Chugach National Forest of some 4,000,000 acres, which includes the next habitable coastal area to the westward. These two areas include seven of the fourteen principal towns in Alaska: the capital, Juneau, and Ketchikan, which ranked respectively second and third in the last census, Sitka, Petersburg, Wrangell, Cordova, and Seward.

The forestry resource is extremely important to Alaska. Its utilization on a major scale is just beginning with the construction of Alaska's first pulp plant near Ketchikan. Its functioning should in no wise be impaired. But there is an aspect of these two national forest reserves, unrelated to the forestry function, which is unique. Nowhere else under the flag do national forests blanket a whole economic area or include and circumscribe a state's principal urban centers. The situation would be analogous to having the national forests occupy the total western fourth of Washington and Oregon and surround the cities of Seattle, Tacoma, and Portland. Recently a small beginning has been made in southeastern Alaska by excluding from the forest reserve, and returning to public domain for disposal under laws and regulations applicable to it, limited areas surrounding these towns. The objective is to enable these towns to develop suburbs and to achieve the normal development of other American cities. But, apart from the fact that even this move, while in the right direction, has only begun, uncertain as to issue and insufficient in scope, one great obstacle to normal development remains. That is that the highway construction policies in these important areas, which include half the principal urban centers of Alaska, are not in the hands of road-building agencies whose mandate and purpose it is to develop highway communications. The control rests in the hands of the regional forester, whose mandate is forest conservation and utilization, and not commercial, industrial, or urban development. The consequence of this anomaly is that, while the interior of Alaska is developing a fine highway *system,* linked to the continental highway system, southeastern Alaska's insignificant road mileage consists of mere short stretches of highway leading only a very slight distance out of each town and connecting with no other community.

The remedy is to exclude from the forest areas the *rights-of-way* for proposed and needed through highways and permit such arteries to be included in the construction program which is rapidly speeding the development of interior Alaska. Such a reform would in no wise interfere with the forestry function but would promote growth, settlement, and other development. Desirable sites within the forest areas should likewise be made easily available on a fee simple basis for the development of tourist lodges.

So much for the basic land problem.

Since its discussion has brought us to the subject of highways, it will be well to continue with it. Highways are indispensable to development and settlement. One has only to observe the springing up of lodges, tourist cabins, and homes taking place in Alaska whenever and wherever a highway cuts through the wilderness to be aware of this visible result. Among the memorials to Congress adopted by the first legislature in 1913 was a request for highway construction. Except for the Richardson

Highway built in the second decade as a low standard road. Congress did nothing (until three years ago), but discriminated grossly and uniquely against Alaska by failing to include Alaska in the Federal Highway Act—except for a limited participation in forest areas. No other territory suffered this discrimination. Alaska's share of Federal funds in the twenty-nine years since the passage of this act has been estimated at $350,000,000. Fractional matching on some formula would have been required, but Congress declined to sanction any formula. World War II's exigencies, however, brought the Glenn Highway, connecting Anchorage with Fairbanks and Valdez by means of the Richardson Highway, and also that part of the Alaska Highway between the Yukon boundary and Fairbanks as well as the Tok cut-off. Three years ago, in consequence of the Soviet threat, Congress authorized a road-building program with an annual appropriation of between 20 and 25 million dollars which includes black-topping the principal highways. Under this program a highway starting at Homer and connecting the Kenai Peninsula has been completed; Seward has been connected with the system. A road into the Forty-mile and to the Yukon at Eagle near the Canadian boundary and a connection with Dawson have been completed. Two other major projects have been begun, namely, a road to Mt. McKinley Park from the Richardson Highway and a highway from Cordova to Chitina over the old Copper River and Northwestern Railway right-of-way.

In addition, numerous shorter farm and access roads have been built. This is a fine beginning, but it should be considered only a beginning. It is fair to consider that Alaska's road-building program came a quarter of a century after the Federal Government had started its cooperative highway aid program with the forty-eight states and other territories. Indeed, the present Federal highway program, although most ably administered in Alaska, is already demonstrating its insufficiency, for surfacing and maintenance are consuming an increasing share of the budget. Thus the Paxson-McKinley Park Highway, begun two years ago, has had its current fiscal year allocation cut to $500,000, and the Cordova-Copper River Highway, which would link the one as yet unconnected city in central Alaska with the territorial and continental highways system, starts with an appropriation of only $650,000, although the cost of the project is estimated at $12,000,000. If the road program is to be effective in building up Alaska and serving its pressing needs, it must expand, and the annual Congressional apropriation—some $20,000,000 for the coming fiscal year—must at least be doubled for the next ten years; at the end of that period this would approximate in appropriation what would have been Alaska's rightful share had not Congress after Congress discriminated against Alaska by failure to include it in the Federal Highway Act. But more pertinent than the argument based on atonement is the fact that Alaska will require, at the very least, the mileage that an annual appropriation of $40,000,000 for the next ten years will construct. A hundred-million-dollar annual program would be even sounder. This is clearly a Federal function, although the Territory which now builds and maintains some smaller road and harbor projects could properly be expected to bring its present two-cent gasoline tax up to the national average, which is about six cents.

The need for harbor projects presents another problem. For years this has been the function of the Army Engineers, but in recent years they have all but ceased to construct in Alaska. The responsibility is, of course, the Congress's. The engineers have studied, surveyed, and recommended many needed projects for small boat harbors to take care of Alaska's fishing fleets, for flood control and much else. These projects remain pigeon-holed. In recent years there has been a tendency to stigmatize such river and harbor projects as pork-barrel projects. That is not the case in Alaska. These are sorely needed projects that have hitherto been beyond the financial means of the Territory and local communities. But the need remains. The failure to provide them checks growth that would otherwise take place.

In a related category is power development. The recent announcement of Alcoa's plan to harness the upper Yukon and to drop some of its waters onto Alaskan territory at Dyea in order to process alumina is epoch-making. Its coming will be the most important single event in the history of Alaska's development. It has several unique aspects.

First is its magnitude. It will call for an initial investment of $400,000,000. It was reported recently in a national magazine that this is the second largest investment ever made in a single plant, being topped only by a steel plant in Pennsylvania which cost $421,000,000. Actually Alcoa's investment will go well beyond $421,000,000 and will be, not the second largest, but the largest investment by a private industry under the flag. It will employ some 4000 people 365 days a year and will have an annual payroll of about $25,000,000. These people will require a town housing 20,000 persons to be built in the Dyea Valley. At least 10,000 more can be expected in neighboring Skagway. The beneficial economic consequences, direct and indirect, to

Alaska stagger the imagination. In itself it will increase Alaska's present population by nearly 20 percent. By itself this plant will supply the most important ingredient hitherto missing from Alaska's economy—a large year-round non-governmental payroll.

Second is the fact that the power to be utilized originates in Canada in the headwaters of the Yukon and adjacent lakes. It is now running to waste and will continue to do so unless harnessed by the force of gravity which the 2500-foot drop to sea level on the Alaskan side of the boundary provides.

Third, the project utilizes a raw material, bauxite, which as far as is now known does not exist in Alaska but will be brought here from Surinam in South America and be partly processed in the States before arrival here. The land on which this development will take place has not been found of any value and has likewise been unutilized, although known and accessible since the days of '98. Thus this project is unique on several counts, and it represents the antithesis of exploitation and wastage of natural resources. The hydroelectric development is essential to this industry, for large quantities of cheap power are indispensable to the manufacture of aluminum.

This very fact calls attention to the urgent need of developing cheap power elsewhere in Alaska to attract industry. Alaska and adjacent Canada have in all probability the greatest undeveloped power potentials on the North American continent. But private industry is seldom in a position to finance such power development. In the diversification of Alaska's economy, which has hitherto been highly limited by seasonal factors, its only principal industries, fisheries and placer mining, operated only in the summer months, and more year-round payrolls are needed. Cheap and abundant power alone will attract them.

The answer—in the absence of private enterprise, able, willing, and ready to undertake the great cost of power production—is governmental development. One project, the harnessing of Lake Eklutna to supply the greater Anchorage area, is under development. It will cost about $30,000,000, supply 30,000 kilowatts. All this is, of course not a grant or a gift, but a loan fully repayable with interest by the users—the City of Anchorage, the Chugach and Matanuska electric cooperative, and the Army. It is an interesting commentary on Alaska's great power needs that some two years before this project's completion the entire output is already preempted. When completed, it will not satisfy the current demand—to say nothing of the expanding demand of the greater Anchorage area. The need is for more power projects, the most promising of which is now the harnessing of the Susitna River. This project, which has been under study by the Bureau of Reclamation, will supply an estimated 400,000 kilowatts, or thirteen times as much as Eklutna. It would generate power at less than ten mills and make it available for 200 miles on either side of the rail belt. The problem is how to get authorization and appropriation for such a project, which, let it be emphasized again, is not a gift or grant but the soundest kind of investment by the government in behalf of private enterprise, and repayable with interest. But how to get it? Congress was, with the greatest of difficulty, even with the potent cooperation of the military and the support of numerous public and private agencies, persuaded to authorize the Eklutna project. A reactionary administration would in all likelihood view other public power developments coldly, even though private capital was unavailable for the purpose. Both the executive and the legislative branches will have to be persuaded. The benefits, let it be ever borne in mind, would be national as well as Alaskan. The representation of two senators and a voting representative would greatly improve the chances of realizing such a project.

It will be seen at this point, and it becomes increasingly clear, that Alaska is largely dependent on the vision and understanding of the Congress, on the whole a distant body with little firsthand knowledge of Alaska's needs and problems and of their intimate relation to the national interest.

And that brings us to another problem—or rather a whole series of problems—one of our greatest problems in Alaska, lack of knowledge. Very little is really known about Alaska and its resources. Research—intensified research, enlarged research, continuing research—is essential.

Yet it is an ironic fact that, while private industry has learned the importance of research, government, on the level where the means for research are provided, has not. When Congress engages in its periodic retrenchment drives, research is likely to be the first victim. Possibly an exception is made of research in the field of national defense, where Congress has responded well. But, in Alaska, defense and economic development, defense and population growth are almost inseparable.

It would be superfluous to stress the importance of agriculture. It is the most basic of all economic pursuits. It is the greatest stabilizer of population. Yet, despite the fact that thirty years ago a land-grant college was established in Alaska, as a result of which it was entitled to certain annual appro-

priations for research and extension work under a variety of Congressional enactments, Congress persistently refused to appropriate the legally authorized funds. Year after year our voteless delegates would plead eloquently but in vain. The appropriations that were made were negligible, far below the sums legally Alaska's, and wholly inadequate. It should have been clear that Alaskan latitudes, with their unstudied climatic, soil, and entomological factors, required specific research of their own. Nothing was done about it until—as with so many recent Alaskan developments—word of intensive and successful agricultural activity in comparable latitudes in Soviet Siberia reached the Congress. Then for the first time a cooperative program of research under the joint auspices of the federal Department of Agriculture, the University of Alaska, and the Territory was provided. It was begun most auspiciously three years ago, even though on a relatively modest scale. But even now it is already menaced by Congressional retrenchment, which will force suspension of some important research already undertaken. Such curtailment is a constantly impending threat which in itself impairs the morale and effectiveness of those engaged in this essential undertaking.

In the field of fisheries, which involves Alaska's greatest natural resource, the Pacific salmon—a field Congress and the Department of the Interior insist on retaining under Federal control—appropriations for research have been almost totally lacking, and funds for enforcement of presumably sound conservation measures always insufficient. In consequence the annual salmon runs are slowly but surely diminishing. The Territory has attempted to alleviate the situation by setting up its own Department of Fisheries, engaging in research, experimenting in the expansion of salmon spawning areas, and even contributing stream guards; but the problem basically is lack of adequate sustenance by long-range governmental planning.

In the field of health it has long been clear that adequate knowledge of arctic and subarctic physiology and pathology were lacking. The question is intimately related to national defense in Alaska. Soviet knowledge in this field, based on long experience in arctic and subarctic latitudes, appears greatly to exceed ours, although since the lowering of iron curtains our information on the subject is largely presumptive. For years the establishment of an Arctic Institute of Health at the University of Alaska or elsewhere in our Territory has been urged upon the United States Public Health Service, the Bureau of the Budget, and the Congress. Nothing has resulted thus far.

In many of Alaska's other problems the Federal Government plays a controlling part. The question of aboriginal or possessory rights or claims requires settlement. Five years ago Congress finally gave evidence of its recognition of the problem by passing the Alaska Timber Sales Act, which froze the fees collectable for stumpage in escrow pending legislation to dispose of the problem. An excellent bill sponsored by Alaska's delegate and endorsed by the Office of Indian Affairs in Washington still awaits action by the Congress.

The judiciary and law enforcement were specifically retained for the Federal authorities under the Organic Act of 1912—except within municipalities. The Organic Act of 1884 provided one Federal judge and four lower court judges, called United States commissioners. Congress provided no salaries for them but arranged that they subsist on the fees they collect for probate and other services from the public. The number of commissioners has grown, and there are now more than fifty, but they are still unsalaried despite repeated efforts to get Congress to remedy this disgraceful state of affairs. Except in the four or five principal cities, these fees, which are expected to furnish the commissioners' livelihood, are insufficient to keep body and soul together. The four Federal district judges who appoint the commissioners have a serious problem in finding competent and worthy commissioners in the smaller communities. The administration of justice—cornerstone of the free society—suffers. Under statehood Alaska would have its own judiciary, and, needless to say it, it would be paid.

The police power—outside the incorporated towns—is likewise vested by the Federal Government in the four United States marshals and their deputies. But appropriation to provide an adequate number of deputies is never made. Congress has grossly failed in carrying out its responsibility for law enforcement in the Territory which nevertheless it has insisted on retaining. A visible symbol of the Federal failure in this field is the Anchorage jail—a Federal institution—whose foulness has been the subject of repeated protests.

The Territory, however, has made an excellent entry into the field of law enforcement by creating an efficient highway patrol, now numbering over forty officers and men, in an endeavor not merely to enforce traffic regulations but also to supplement the Federal Government's feeble efforts. The gap, however, has not yet closed, and the responsibility, as long as Alaska remains a Territory shackled to the Organic Act of 1912, is still the Federal Government's.

Progress in Alaska has, of course, brought its

problems. It is gratifying that they are the problems of growth and not of shrinkage. But basic to an adequate solution of these problems should be the understanding that Alaska's growth and development are and should be of great national concern, and that their rapid attainment is in the national interest. The need for better and fuller Federal cooperation is emphasized not merely by that concept, but also by the long years of neglect, by the continuation of many Federal practices of omission and commission that are unjustifiable, and by the vital importance of Alaska in the face of international events.

If it be urged that Congress raise its sights and increase its appropriations for essential objectives in Alaska, there should be no disposition to evade any responsibility or participation that can properly be borne or shared by the 165,000 people now resident in Alaska. As of today they are, by and large, doing their part. They can without difficulty today support *a* state. But Alaska, from the standpoint of national interest, should be viewed as something more than just another state, be it the forty-ninth or the fiftieth.

Federal policy should keep as its objective not merely economic development of Alaska, but also parallel political development and social development which require the fullest measure of self-government obtainable under our American system.

However, given the need of fulfilling Alaska's destiny as a *national* objective, statehood should not and cannot write *finis* to substantial federal assistance in achieving that goal. Nor is this postulate inconsistent with the demand for the full political equality of statehood. Actually statehood may be considered a helpful and indeed an indispensable instrument in helping the nation obtain its goal in Alaska. Politically, Alaska may be just another state when Congress acts and the necessary preliminaries have been complied with by Alaskans. But materially and ideologically the nation can have incorporated in its design and resource a great northern domain, in essence a new domain in its developed potency, militancy, and resourcefulness. That domain can embody all that is best in the American way of life and advance the front of democracy farther west and farther north than it ever has been.

SPACE ROCKET

Now the velocity of speed,
As scientists have reckoned,
By gravity has been decreed
At seven miles a second.

Take off from earth! No longer bound
To either time or place;
No longer tethered to the ground,
But free to wander space.

What worlds await us, once we dare
To leave the earth behind,
Piloted through realms of air
In rockets of the mind.

MAE WINKLER GOODMAN

Cleveland, Ohio

Experimental Discoveries Announced at the Meeting of the American Physical Society Fifty Years Ago

GORDON FERRIE HULL

Professor Gordon Ferrie Hull is professor emeritus of physics of Dartmouth College. He was born in the province of Ontario, Canada, and was graduated from the University of Toronto. He received his Ph.D. degree from the University of Chicago and also studied at Cambridge and Berlin. Only a few of the facets of his interests are mentioned here. He has made outstanding contributions to the study of light and ballistics; his teaching influence has been felt in many colleges and universities; his devotion to the field of physics has been shown by active participation in the programs of the American Physical Society, the Association of Physics Teachers, and as Vice President, AAAS Section B.

IN THESE DAYS of almost frenzied activity in research in realms beyond the ken of the farthest gazing physicist at the beginning of this century, it may seem wasteful of your time to deal with the program of the American Physical Society fifty years ago. However, the Society's secretary having invited the paper, to him belongs the onus or the credit. In seeking for one to fill this role, our secretary was unfortunately limited in his choice. Of those who presented papers at the Denver meeting of 1901 and the Washington meeting of 1902–1903, I am the only one now living. Time marches on. Our secretary also desired to emphasize the fact that the papers by E. F. Nichols and myself on the pressure of radiation were presented at those meetings. Indeed, he asked that I give an address on "Fifty Years of Light Pressure." I was reluctant to do so for the reason that there were other papers presented at the Washington meeting of Christmas week, 1902, which were of very great importance, an importance not recognized then or even now. I asked that I be permitted to give a paper on the above title. The experimental discoveries referred to were the pressure of light, the identification of the alpha particle and cosmic rays. I shall deal with these in detail later.

Discovery of the Pressure of Light

I first met E. F. Nichols at the dedication of the Yerkes observatory in 1897, at which function—though neither of us was an astronomer—both were delegates. He had been working on methods of extending the spectrum of an incandescent body toward longer waves, and he had devised instruments for detecting and measuring the energy. I had published an article on the measurement of very short electric waves. Thus according to Maxwell's marvelous electromagnetic theory, still quite new, we had been working in neighboring realms.

A large part of Maxwell's theory had developed during the years 1861 to 1873 and had been experimentally verified by Heinrich Hertz in the discovery of electric waves. But there was one item not yet experimentally verified—it was that a beam of light falling upon a surface should exert a pressure equal to the energy density of the radiation in front of that surface. (This theoretical result had also been derived by A. Bartoli in 1876 from thermodynamical considerations.) At the Yerkes meeting Nichols and I had numerous discussions about all the extraordinary conclusions of the Maxwell theory.

Mr. Nichols was called to Dartmouth in 1898, I in 1899. By the summer of 1900 it was perfectly clear that we were detecting the pressure of light as contrasted with the very disturbing effects due to gas action. No publication of our work was made at that time except locally. Our first paper was read in Denver in August, 1901. In it we showed that we had measured all the quantities involved so as to give an agreement of 20 per cent between

the experimental and theoretical values. But there was omitted from that paper the almost exact agreement between the two values when the energy density had been measured by a bolometer method which we had reason to believe was faulty. Our more complete paper was presented at the Washington meeting in December, 1902. This gave an agreement within 1 per cent between the two values, but there was an error in that paper of about 6 per cent which was not detected for about thirty years. Our more exact work, together with the confirmation by Lebedew, established the reality of light pressure and verified the theoretical result set forth by Maxwell in 1873 and by Bartoli in 1876. A beam of light possesses momentum; and the pressure of light became a phenomenon of nature as universal as gravitation.

Before going on to consider the consequences of this phenomenon, let me call attention to one feature of our work which was of great importance. We plotted the positions of the torsion system at quarter period intervals after exposure to light. Thus we noted that the initial motion of the vane, whatever the pressure of the air in the bell jar, was always away from the light. That initial motion was due to light pressure. Had William Crookes done this, had he made his work quantitive, he might have found that light itself produces a force on a surface on which it falls. For Crookes labored continuously for about six years, from 1873 to 1879, on work which resulted in the Crookes radiometer. He and his assistant were extremely ingenious in designing light mills, but they did not have the technique of using quartz fibers for suspensions and for producing a balancing and restoring force against the action of light. Let me say that quartz fibers are still the supreme materials for this purpose. Yet though Crookes failed to establish the existence of light pressure, his keen intuition led him to say in his Bakerian Lecture of 1879, "The phenomena in these exhausted tubes reveal to physical science a new world—a world where matter may exist in a fourth state and where the corpuscular theory of light may be true."

I have said that there were three important experimental discoveries announced at the meeting of 1902–1903. Of these, that of light pressure was perhaps of the least importance, yet it is probable that it produced more excitement among the members present than any other paper of that session, simply because we gave an experimental demonstration that was completely convincing. The demonstration was the more exciting on account of the fact that various prominent physicists had predicted that, though theory required that light should produce pressure, its amount was so small that it probably never would be detected. This statement was made, for example, by Drude, one of the foremost physicists of that time, in his excellent textbook on optics, the English translation of which appeared in 1902.

After the reality of the pressure of light had been established, we had to assume that not only is there an attractive force between masses, there is also a repulsive force. Both follow the law of the inverse square of the distance between the masses, but there the similarity ends. The repulsive force depends on the temperature of the masses, their surfaces and absorption coefficients, and the ionized condition of their vapors. The gravitational action of two masses depends only on the masses and distances. It cannot be shielded in any way. The repulsive forces depend on all the variables above, but not on the masses. They can be completely shielded. Consequently, the repulsive forces frequently cannot be computed. If the bodies are receding, the pressure is lessened. Does gravitation depend upon the radial speed? I asked one of the foremost philosophical mathematical physicists of our society that question, and he replied that if there is an answer he does not know it. One of the younger physicists here should try to obtain an answer.

For a spherical particle of the mean density of the earth, with a totally absorbing surface, and a diameter of 2×10^{-5} cm, the radiation pressure and the gravitational pull by the sun would be equal. Here the solar radiation constant has been taken as 1.92 calories cm^{-2} min^{-1}. Particles of the same density but of smaller diameter would be driven away from the sun. For a sphere of water the critical diameter would be 5.5 times the above value, or 1.1×10^{-4} cm. Particles the wavelength of the edge of the infrared, just smaller than the above, would be gradually forced away from the sun, while those just larger need not move quite as fast as the earth to be in equilibrium in the earth's orbit.

There are limitations to these arguments. If the diameter of a particle is small compared with the wavelength of light, the pressure of radiation becomes very small.

There is a further effect which may enter. To show how baffling it is, I give its history. Let us consider a spherical mass, a few centimeters in diameter, at the earth's distance from the sun. Presumably its surface would have the same temperature as that of the earth, and it would radiate energy at the same rate. But on account of its speed forward there would be a greater pressure on the front than on the rear surface, since the

nergy density in front is greater than behind. Let s call the excess force F. In 1903 J. H. Poynting omputed F to have a certain value, $Rv/3C^2$, where R is the rate at which the particle is radiating energy, v is its velocity, and c that of light. Ten years later Sir Joseph Larmor took up this problem and arrived at a value of F three times hat of Poynting. A year later he revised his value o $3/2\,F$. Then in 1918 Leigh Page of Yale—whose ecent death is mourned by all members of our ociety—by making use of relativity operations omputed that F was exactly zero. Twenty years ater another of our members, H. P. Robertson, a mathematical physicist of the highest order, now f California Institute of Technology, then of Princeton, under the stimulation of that seer in astronomy and physics, our own Henry Norris Russell, made an elaborate analysis of the problem, using the methods of relativity. Neglecting small quantities of the second order, he arrived at the value of $3F$, that first obtained by Larmor on classical grounds.

On account of this retarding force, a particle cm in diameter and of the density of the earth 5.5 g/cm² at the earth's distance from the sun would be slowed down and would very gradually spiral into the sun. Smaller particles, but larger han the critical size, would spiral in correspondingly faster.

Long before the experimental proof of the reality of the pressure of light, that property had been applied to account in part for various phenomena, such as the solar corona, zodiacal light, comets' tails, and northern lights. That there were fine particles in the tails of comets which were driven away from the sun by light pressure was suggested by Kepler in 1619, by Euler in 1740, and was discussed by Fresnel in 1825. In the 1890's, Arrhenius discussed at great length the possibility of this application. Now Kepler and most of those who followed him had regarded light as corpuscular, but when the wave theory of light was apparently established it was not evident that there would be any pressure. Even after the theoretical statement by Maxwell, it was rejected by some of the foremost astronomers of the closing decades of the nineteenth century, for example, by C. A. Young and Simon Newcomb. But there seemed to be no question whatever as to there being a repulsion of the particles of the tails by the sun, and the repulsive force had different values, even for parts of the tail of one comet.

However, we thought that we could make a laboratory comet's tail. Into a glass tube shaped like an hourglass we placed some puffball spore, lycopodium powder from which the oil had been driven by heat. The tube was exhausted. When a beam of light was focused on the particles after they had fallen through the constriction, the particles, at least many of them, were blown away from the light source. To us at that time it appeared that our demonstration in Washington was too successful. The force driving the particles away was of the order of the earth's gravitational force, which would make it 160 times the sun's gravitational force. We thought it should be small compared with the earth's gravitational force. The repulsive force is large compared with solar gravitation on many comets' tails, but we didn't know how large. Here are some data collected since 1902. For the Moorehouse comet of 1908 the ratio of repulsion force to the sun's gravitational force was computed by different observers to be 62, 72, 162, 105, 151, 88, 156. For the Halley comet of 1909–1910 the ratios were 194, 70, 90. Now the tail of a comet consists usually of a number of tails, all with a fleeting existence. A comet is constantly losing and replenishing its tails. These tails are frequently self-luminous ionized hydrocarbon molecules, and Karl Wurm of Potsdam in 1935 estimated that the repulsive force in an ionized carbon monoxide molecule would be between 60 and 120 times the solar gravitational force.

No two comets' tails are alike, and in that respect at least our laboratory comet tails closely followed nature; no two of our tubes gave the same result. But comets' tails are self-luminous, whereas our comets' tails were black particles.

There are several ways in which light pressure enters into physical problems. Boltzmann used it in deriving the second law of thermodynamics. It can be used in deriving the law of the adiabatic expansion of black body radiation $pv^{4/3} = \text{constant}$[1] and from this Wien's Law follows. It is used in deriving the change in wavelength in the Compton Effect—indeed, in every case in which the momentum of a photon is taken as hf/c.

Although we have indicated that the pressure of radiation on a particle of molecular size would be zero, and therefore we might expect that radiation would not exert any force in a vapor, still it is clear that if a mass of vapor absorbs a certain fraction of radiant energy passing through it, that same mass would absorb the same fraction of the momentum and would consequently experience a driving force.

Not only in regard to comets' tails but also concerning the expanding nebular layers enveloping a nova, the pressure of radiation enters. Innumerable papers have been written on these topics dur-

ing these fifty years. They are still going strong.

However, there is one result of the marvelous Maxwell theory that has been passed over. The statement that there is a pressure on an absorbing surface equal to the energy density in the radiant beam established the relation between mass and energy, $E = mc^2$. To make this conclusion convincing, let us consider a light beam one square centimeter in cross section. Let there be n particles or photons per cubic centimeter, each of mass m and energy E. The energy density is nE. The number of particles striking the surface per second is nc where c is the velocity of light. The momentum of each particle is mc. Hence the total momentum absorbed per second is nmc^2. But this equals nE. Hence $E = mc^2$. You may raise the objection that this applies only to the fictitious or quasi mass of a photon. But a photon has energy—it has mass. Moreover this energy and this mass are absorbed by the target. Its energy and mass have both been increased, but with the above relation holding. So for all mass and all energy the relation $E = mc^2$ holds.

Attempts have been made in recent years to verify the Maxwell-Bartoli formula for the pressure of electromagnetic waves. But here there are great difficulties. For example, K. Fritz[2] used energy of wavelengths from 112 to 295 cm directed against a resonant antenna of 1 mm diameter. What is the energy density in front of such an antenna? It receives energy from many directions. What is the vector sum of the forces?

Recently a similar experiment has been performed by Nello Carrara and P. Lombardini of Florence[3] using 3-cm waves. This was concerned with the pressure inside and just outside the mouth of a wave guide; and it was hoped that it would provide a method of determining the power propagated along the guide. An experiment completely verifying the Maxwell theory for electromagnetic waves still is lacking.

Before proceeding to discuss the other two scientific discoveries, I desire to pay a tribute to the memory of Ernest Fox Nichols. I think I cannot do this better than by quoting from an article I wrote, "Reminiscences of a Scientific Comradeship."[4] "Always there stands out the keen intuition of Dr. Nichols, his hatred of sham, his loyalty to friends. The four years spent with him were, for me, years of strenuous but congenial labor—years of a memorable scientific comradeship."

Identification of the Alpha Particle

In 1899 Rutherford divided the rays coming from radioactive materials into two classes, the penetrating and the easily absorbed. The nature of the penetrating rays was quickly solved. There were two kinds—those like x-rays and gamma rays and those of electron streams. But the easily absorbed rays, the alpha rays, what were they? Rutherford subjected them to the action of electric and magnetic fields. The results were submitted in his paper given at the Washington meeting. His conclusion was that they consist of particles which have the mass of a very small atom—either hydrogen molecules with a single charge or helium atoms doubly charged. He took the latter view. Now his experiments, which look so easy, were attended with the greatest difficulties, as may be seen from the fact that he was the only one in the world at that time, or for several years, to make those measurements. True, Henri Becquerel attempted similar measurements; but he came to the conclusion that the mass of the particle, whatever it was, constantly increased as it moved along its path. Hence no significance could be attached to it. I heard Becquerel at the international conference in Liége, Belgium, in 1905, make such a statement and claim that Rutherford's findings were in error. But one year later, four years after Rutherford made his measurements, Becquerel acknowledged before the French Academy that Rutherford was right and he was wrong. Thus the leading scientist of La Belle France bowed to the youth from primitive New Zealand.

It may be noted that Becquerel claimed that the apparent deviation of the alpha rays as found by Rutherford was due to the large deviation of the beta rays, which upon striking the walls of the enclosing container were reflected so as to give the appearance of a positive charge. Also Rutherford's conclusions regarding the nature of the emanations was challenged by M. Curie. But in both cases Rutherford proved that he was correct.

The new knowledge concerning alpha rays was fitted in at once to the extraordinary theory put forth at that time by Rutherford and Soddy,[5] the theory that radioactivity results in a succession of chemical changes in which new chemical atoms are formed by the ejection of an alpha or beta particle from the parent radioactive atom. They called it atomic disintegration, an unhappy phrase since it implied that the offspring was rather inferior to the parent. This point of view is frequently held by human beings. Fortunately it is not always true, else the human race would be in a more deplorable condition than it is at present. Rutherford and Soddy were perplexed as to the names that were to be given to the new atoms. But they boldly named the unknown offspring in the family trees

eaded by uranium, thorium, and radium. In the last case, for example, they named five members, radium, radium emanation, radium excited activity I, ditto II, ditto III, and subsequent unknown particles.

Rutherford and Soddy[6] established one other fact of vast importance, a prophetic fact, namely, that the energy involved in a radioactive change must be at least 20,000 times, and may be several million times, as great as the energy of any chemical change. (Also they deduced "that the energy latent in the atom must be enormous compared with that in ordinary chemical change.") They foresaw the possibility of what we now call atomic energy and the atomic bomb. How many of the physicists who heard Rutherford's paper envisioned the vast changes which have come to the domain of physics—indeed, to the whole world—by disclosures made by Rutherford, and by Rutherford and Soddy, at that time?

Cosmic Rays

The third discovery announced at the meeting of fifty years ago was that of a new penetrating radiation in the atmosphere, the cosmic rays—or better, the celestial rays—of the present time. There were two papers regarding these, the first by E. Rutherford and H. L. Cooke, the second by J. C. McLennan and E. F. Burton. Although Rutherford and Cooke gave as their title "A Penetrating Radiation from the Earth's Surface," they proved conclusively that in the neighborhood of Montreal such radiation did not come from the earth's surface. By noting the rate of discharge of a well-insulated gold-leaf electroscope, it was seen that there was a very penetrating radiation present, first, in the physics laboratory of McGill University; then in the library, which was entirely free of radioactive substances; and finally, on the campus of the university. In the last case the electrometer was placed on the frozen earth at a distance from the laboratory. In all cases the rate of discharge decreased when metal screens or large screens of water were placed around the instrument. As much as five tons of pig lead, of 5 cm thickness, placed around the instrument when it was on the frozen ground resulted in a decrease of 30 per cent. When the screens were removed, the rate of discharge returned to its original value.*

* In *Time* magazine of January 19, 1953, there is an item released by the Atomic Energy Commission regarding the "hottest" radioactive source. It is 10 pounds of cobalt 60. Prepared in the Brookhaven Laboratory, it was sent to California in a 2-ton lead shield. But Rutherford and Cooke used 5 tons of lead in an attempt to shield their electroscope from the penetrating radiation which they had discovered.

Thus the authors proved that there was a very penetrating radiation in the atmosphere, that it did not come from radioactive substances or from the earth in the neighborhood, and that it came from all directions except from the earth.

Now Rutherford knew something about penetrating radiation. He was perhaps the foremost man in the world in researches on radioactive matter and the rays which such matter emits. He had worked with the penetrating radiation from thorium and radium, and he recognized this radiation in the atmosphere as being out of the ordinary. But his great interest at that time was in analyzing radioactive substances and in building up the radioactive series which illustrated the extraordinary theory that he and Soddy had just put forth. He did not follow up this first work on cosmic rays, but beyond question he was the first to call attention to this extraordinary phenomenon—one that for fifty years has been the subject of a vast number of experiments, that has held the attention of physicists all over the world, and that is the subject of articles set forth in millions of pages.

The paper by McLennan and Burton had as its title: "Some Experiments in the Electrical Conductivity of Atmospheric Air." Again the rate of discharge of a well-constructed electrometer was observed. The authors at first were of the opinion that the metallic wall of the electrometer was slightly radioactive, and they made several tests with electrometers made of different metals. Finally they immersed a large, heavy electrometer into a very large tank of water, and they found that the rate of discharge decreased by 37 per cent. For a smaller tank the decrease was 17.5 per cent. They then came to this clear conclusion: "From these results it is evident that the ordinary air of a room is traversed by an exceedingly penetrating radiation such as that which Rutherford has shown to be emitted by thorium and radium and the excited activity produced by thorium and radium."[7]

Work upon this penetrating radiation was carried on intensively at the University of Toronto. C. S. Wright[8] in 1907 arranged his apparatus so that it recorded continuously, day and night, the intensity of the radiation. Also, he made observations not only in the physics laboratory but also in several buildings of the university, at the top of towers open to the sky, on the ice of Toronto Bay, and on board a vessel moving back and forth across Lake Ontario. G. A. Cline[9] in 1908 repeated and extended these observations and came to the following conclusions: "It is possible that the penetrating radiation now present *at the surface of the*

earth has its origin in the sun or in other celestial bodies." You will notice that he did not say it came from the earth, but that it was being investigated at or near the surface of the earth. The Toronto name would be celestial rays, and I think that is a better name than cosmic. What do we know about the cosmos? The work of these Toronto investigators made it perfectly clear as early as 1909 that the earth was not the source of the radiation. The problem then was, how were observers to take their apparatus away from the earth?

By this time physicists in various countries were making measurements of this radiation. In Canada free ballooning was not an outdoor sport. In Switzerland and Austria it was. A. Gockel went up 4500 meters over Zurich. He found the same radiation, sometimes of more intensity, sometimes less. Observations now became more definite by the use of the Wulf electrometer, in which platinized quartz fibers replaced gold or aluminum leaves. It was used by V. F. Hess during several ascents. At first there was no clear indication of any increase in the ionization; but finally, in 1912, on the seventh ascent from Vienna, Hess found a very rapid increase for a change in height from 2000 to 5000 meters. In the following year Kolhörster went up to 9000 meters and also found a large increase in ionization. Then came Millikan, who in 1922 sent up his instruments ten miles. So it continued. And now we ask the question—who discovered cosmic rays? Was it those who read the papers before this Society fifty years ago, or was it this one or that one who added fact after fact to the original observations? Was it Gockel or Hess or Millikan who showed that the radiation was very strong at considerable heights above the earth's surface? Or was it Clay and Arthur Compton, who showed that this radiation was not entirely, nor even chiefly, of the nature of gamma rays, as had been thought and as Millikan strongly contended, but was of the nature of charged corpuscles, influenced by the earth's field? Or was it Carl Anderson, who discovered the positron, and very specially the meson, in the rays? Or was it Street and Stevenson of Harvard, who very definitely confirmed Anderson's discovery? Or was it C. F. Powell and his group at Bristol, who found only five years ago a whole family of mesons in these rays? All these may be regarded as discoverers, but all have been observing the same radiation. My opinion is that if any one man is to be credited with the discovery, that man was Rutherford; if any group, it was Rutherford and Cooke at McGill University and McLennan and Burton at the University of Toronto—and the papers announcing the discovery were read at the meeting of this Society fifty years ago.

What a fifty years it has been in physics! One hundred and ten years ago Alfred Tennyson wrote in Locksley Hall,

> "I dipt into the future, far as human eye could see,
> Saw the Vision of the world, and all the wonder that would be."

But he did not see—no poet, no physicist of even fifty years ago envisioned what we have actually seen—the incredible extension of our domain. The program of this meeting gives evidence of its vastness. What a joy it has been to have been working in this domain all these years. We are always at the dawn of a new day.

References

1. Hull, G. F. *Elementary Modern Physics.* New York: Macmillan, 423 (1949).
2. Fritz, K. *Ann. Physik,* **11**, 987 (1931).
3. Carrara, N., and Lombardini, P. *Nature,* **163**, 171 (1949).
4. Hull, G. F. *The American Physics Teacher,* **4**, 61 (1936).
5. Rutherford, E., and Soddy, F. *Phil. Mag.,* **4**, 370, 569 (1902).
6. *Ibid.,* **5**, 589, 590 (1903).
7. McLennan, J. C., and Burton, E. F. *Phys. Rev.,* **16**, 192 (1903).
8. Wright, C. S. *Trans. Roy. Soc. Can. III,* 85 (1908).
9. Cline, G. A. *Ibid.,* 111 (1909).

The Financial Threshold of Alaska*

ELMER E. RASMUSON

The author is a native Alaskan, born in Yakutat. He was educated at Harvard University, which granted him B.S. and M.A. degrees. He has been a member of the Anchorage City Council and City Planning Commission and a Director of the Chamber of Commerce. Formerly of the Anchorage accounting firm of Arthur Andersen and Co., he has been President of the Bank of Alaska since 1943.

WHEN I think of a threshold, I picture a traveler standing at a doorway with some hesitation, preparatory to entering a new environment. The incident is full of question. Will he stand there for some time, with anxiety mounting the while? Will he step backwards and not come in? If he does step in, will it be timidly or with a boldness that inspires confidence in all who watch? Alaska is in such position today. A threshold is an intermediate point, and it implies change. It is often a point of decision. But, to know whether the movement will be forward or backward, and at what period in time and at what rate, implies an appreciation of all the background leading up to the present.

To know where Alaska is going necessitates an understanding of why and where it is today. Let us start with geography. In location and climate Alaska is northern, and even arctic. The coastline is long, with mountains rising at the water's edge along most of the southern coast. This coastline is further sealed off from the interior by natural surface highways—the great rivers—which flow from the north and from the west.

Small wonder then that our economy has been built primarily in the coastal area. Only one city in Alaska with a population in excess of 1000 is not on the coast. A natural consequence is an extreme seasonality of all endeavor which has been a troublesome factor in practically everything in Alaska. In these factors and the size of the country—one-fifth that of the United States—lies the explanation of the diversity of business and production. It is thus easy to understand why we have had a philosophy of impermanence. This philosophy has also produced an insulated outlook in our population. Many residents have felt closer to the states they came from, vacation in, and expect to return to. The initial registration this year at the University of Alaska did not include one student from several of our southeastern cities. Small wonder that a fisherman, for example, is not inclined to invest savings in Alaskan mining or agriculture. This situation tends to aggravate the deficiency of capital in Alaska.

As a result, Alaska has a pioneer or frontier economy. The population has been predominantly male. There has been a strong emphasis on exploitation. This is equally true of the current construction industry and of those dependent on natural resources.

We have a concentration on production and a relative indifference to commerce and trade. This, of course, parallels the history of any similar developing country. The political and social significance is obvious.

In finance, we have a high gross return on capital, the result of scarcity and risk. Since capital opportunities in Alaska must compete with all the states and indeed the world, Alaska is relatively unattractive to either outside or home capital.

In marketing, we have even today a trading-post philosophy of high markup which is satisfied with low turnover. That means few real sales and clearance of goods, and emphasis on retail merchandising rather than wholesaling.

Some of the financial consequences may be briefly listed. Our demand for capital far outstrips our own capacity to supply. Although short-term bank money is available through participation of Alaskan and stateside banks, there is no real investment capital as in the older population centers. There are no insurance companies lending in Alaska, except on a government-guaranteed basis, and little stock brokerage.

* Based on an address presented at a general session of the Third Alaskan Science Conference, Mt. McKinley National Park, September 22–27, 1952, sponsored by the Alaska Division of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The high-cost economy of Alaska thins the dollar even more than in the States and circumscribes operations in the Territory. The same capital can leave Alaska and go to the States and with lower costs accomplish a successful unit. A notable example of an industry starved for want of capital is Alaskan agriculture.

The tourist industry is limited by high seasonableness in Alaska and lack of boat and hotel space in the summer—the best tourist time. Alaskan banks have their own special impact of seasonality. Bank deposits increase in the fall, when merchants and other producers pay off their loans. In the spring, when deposits are down, comes the demand for seasonal loans; these funds are drained off in payments to the States. Incidentally, this problem is intensified by concern over the financial consequences that would come with evacuation under wartime orders. Because of the absence of sufficient accounting and auditing services in Alaska, there is a tendency in Alaska banking to lend more on real estate security than on financial statements.

Another evidence of our intermediate development is the relative scarcity of corporations as a form of business organization. Alaska is still primarily a land of proprietors and partnerships, although this is changing.

Our short biennial Territorial legislative sessions have not been able to keep pace with Alaskan or outside development. In consequence, many statutes which business elsewhere has come to regard as indispensable are lacking in Alaska. Furthermore, the emphasis on government activity in Alaska during and since the war has produced a negative attitude of legislators toward business. This is not a hostile attitude, but rather an unconscious indifference, because the daily livelihood of such a substantial proportion of the Alaskan population does not at present depend upon private business. In the competition for capital this has an adverse effect on prospective investors.

What are the possibilities for the future development of Alaska? The first is that Alaska may stand still. This does not seem a reasonable likelihood because rarely does a country stagnate, though change is often temporarily masked by a consolidation of position. There is too much inherent instability resulting from the pushing forward of special forces. For example, the expansion in transportation and military defense alone in recent years in Alaska produces a pressure on other economic forces that cannot be denied. Therefore, the conclusion is that Alaska must move.

Will it move backward? For this possibility to become a reality, many private and public investments would have to be abandoned; such an event would be strongly resisted by the rigidity of modern economic forces. We pride ourselves on economic flexibility, but actually the present and growing tendency is the opposite.

Many people ask about the importance of military construction as a prop to Alaskan economy, and about what is going to happen to Alaska when this construction boom ends. Unfortunately we do not have a quantitative analysis, but surely its significance is greatly exaggerated. Only a small percentage of these gigantic appropriations ever reaches Alaskan merchants: half of the appropriations is spent to purchase materials outside the Territory; from the balance must be deducted the cost of employing labor in isolated places, the cost of construction of military camps, and the funds sent to the States by the transient construction crews. This does not mean that construction is not important. It does mean that military construction, as opposed to military operation and maintenance, is not covering an otherwise unbridgeable gap, and, dollar for dollar, it is not to be compared, say, with the value of farm produce grown in Alaska.

Incidentally, as an example of the extent of seasonableness and impermanence in the present Alaskan economy in a military construction area, here are some statistics from The National Bank of Alaska. Over 50 per cent of closed-out accounts were in existence less than 30 days, and over 80 per cent were in existence less than 90 days.

Actually it is much more difficult to go backward than forward. A retrogression in Alaska would mean a sharp reversal in non-economic motives of national defense and development philosophy for the Territory. The prophets of depression have much the weaker case, and they argue for a movement which is contrary to trend. However, there are more positive indications that Alaska's step across the threshold will be forward and onward.

Traditionally, economic demand for goods and services has been in terms of a price. Even if Alaskan costs are not reduced, an increase in total demand, such as an increase in Alaskan population, will stimulate economic development. This increased demand should result from military or other movements of population to the Territory for non-economic reasons, and from birth increases, provided that they are not lost by emigration to the States. Foreign immigration would be a population stimulant if national policy were modified to permit it. A depression in the States would have the same effect.

This increase in demand can arise particularly with respect to non-competitive goods or services

The University of Alaska campus at Fairbanks (U. S. Bureau of Reclamation).

Examples are the tourist trade attracted to non-exportable scenery and industrial demand for special products of the forests, mines, or sea. The field is tremendously expanded when the possibilities of new products such as oil and plastics are considered.

However, it is in the area of cost reduction that the possibilities of increased demand in Alaska are the most intriguing. The most assured development with far-reaching consequences is that of hydro-electric power. This is an inexhaustible economic force, and through it Alaska, having a tremendous cost advantage, will break the vicious bonds of its high-price import economy. This resource can attract an entirely new industry and involve an economic revolution; in fact, the Aluminum Company of America has already announced plans for its Taiya project. In addition to new industry, cheap power will stimulate many mining and forestry operations now marginal in the national market.

Improvement in transportation is another field of cost reduction, in both time and ton-mile costs. We have already seen it in the field of air transportation; it is coming on land with road extension and the hard-surfacing program, and railroad improvements. It is to be hoped that the problems of ocean transportation can be solved to permit expansion of movement by the sea.

Of special significance to Alaska is any development which produces a back-haul. This is doubly effective because the exported product not only yields production benefits but also tends to reduce transportation costs further by permitting round-trip costs to be assessed against two cargoes. One of the reasons why cessation of military construction will not provoke a recession is that automatic offsets arise from the labor and transportation thereby made available. The necessity for overtime will be reduced, and competitive labor demands, as in the field of agriculture, can be thereby satisfied. The stimulation of agriculture will in time tend to reduce living costs and bring Alaska more into line with the States. Additional storage facilities will extend the marketing season and farm incomes. The extension of local feed production has been effective in reducing livestock and milk costs.

With increase in population come improved efficiency, a larger and more trained labor force, and more skilled management. The population tends to become more satisfied and stabilized, and transients become permanent residents. This re-

duction in turnover is reflected immediately in lower operating and construction costs.

If, in addition, the improvements that can logically be expected to come through technological invention are considered, it seems reasonable to conclude that Alaska's costs and prices will improve in relation to those of the States.

Economic demands are usually thought of in terms of price. However, more and more demands are becoming non-monetary in origin and are not equated with supply through price. The importance of this phenomenon increases as the importance of government is expanded. The best example is national defense. A strategic location like Alaska's cannot be measured in terms of money. Is it not unreasonably narrow, then, to regard military spending in Alaska as a temporary construction problem? In the first place, obsolescence proceeds at such a fierce rate that a continuous construction program of some degree seems assured. In the second place, maintenance and garrison of the facilities are a necessity for the foreseeable future, and this provides much greater and longer-term economic stimulation than construction.

Another stimulating pressure is the national obligation of the United States to develop all parts of our country including our Territories. It might be called the conscience of our nation. Although it does not have a monetary origin, it is a real and dynamic force in our economy.

As international complications strain our national economy, production is rechanneled and price is limited as an effective demand factor. The most extreme minimization of price comes under rationing, for then allocations rather than price determine the demand. For the producer hard-to-get materials are stimulated, and for the consumer travel, tourism, and recreation are favored. Alaska has had substantial stimulation from these causes, and, although they may not be continuous in the future, they can be expected to materialize forcefully and periodically.

Economic development has many psychological barriers. Alaska's greatest obstacle is its lack of political equality. With statehood, Alaska would be one with the States in the minds of countless prospective settlers and investors. This would make population and capital shifts to Alaska more inviting. In addition, the expansion of various government services would increase the demand for specialized labor skills. And, in turn, expanding population from any source stimulates demands for additional goods and services, more public improvements, more varied living, and so forth.

It would be most difficult to predict the time and the rate of this anticipated development. Undoubtedly a sharp focal point would be an event such as statehood or the aluminum development.

This discussion would not be complete without some anticipation of Alaska's financial position after the threshold has been crossed. A common presumption is that Alaska would be like the western states, except for differences in climate and geography. But Alaska will probably be different because of the national and world changes that will have taken place by the time Alaska comes into its own. It is exciting to realize that we can shape its destiny if we are conscious of our power, make scientific use of our collective knowledge, and are sincerely interested in the results. Our political future is what we make it. For example, we need not start out with a predetermined county organization. We can have a fresh approach to the suburban problem. With good transportation and available land, there will undoubtedly be a lack of concentration within the legal limits of cities. For example, at present, two-thirds of the population of the Anchorage area resides outside the incorporated city limits.

Social welfare will surely receive great emphasis in our future expansion. As a result a greater percentage of our income will be spent through public channels, and substantial tax rates will probably be required. Because of the size and diversity of Alaska, and the subdivision according to judicial divisions, there will probably be a tendency to channel funds through the territorial, or state, government, in order that the more needy areas can be helped through contribution by the more developed portions.

Our development will at first be based on natural resources. There will be continuous emphasis on cost reduction, because Alaska starts off with a high cost economy. This is one of the most important differences between conditions in Alaska and the usual situation encountered in developing a new area. Our difficulties will be comparable, say, to Venezuela, which is endeavoring to stimulate agriculture and manufacturing in an economy of high prices caused by almost a total reliance on oil exports.

High costs tend to attract the introduction of machinery to save labor. This in turn emphasizes the need for additional capital, which must come from outside Alaska; such capital results in nonresident ownership of our industry. The pace of our development will to a marked degree be limited by our ability to attract and hold capable management.

Robertson River Bridge on the Alaska Highway, a link in the road system opening up Alaska (U. S. Bureau of Reclamation).

If our Alaskan development is forthcoming and if it needs substantial amounts of capital, it is inevitable that government will play an important source role. In the field of transportation, the Federal government operates the Alaskan Railroad, and the Territorial government the Juneau-Haines ferry. In agriculture, the Alaskan Rural Rehabilitation Corporation handles the sale of most of our agricultural land and our federal agencies finance the improvements and production of crops.

Public power is developing the Eklutna project near Anchorage, and undoubtedly it will proceed with other hydroelectric developments. To stimulate housing construction in Alaska a special Congressional act was passed with both government guarantee and loans. The evidence indicates that under government guarantee the lending in the future will gradually be taken over by private banks.

Banks have always played a versatile role in Alaska and should continue to do so. Probably a secondary market will be needed for long-term investments such as deferred RFC participations until insurance money is available for conventional loans.

As Alaska grows, there will probably be one or more local insurance companies. With the transition to the corporate form of organization, a local stock exchange will eventually arise. As wealth accumulates and the population increases, both corporate and individual trusts will come into common use. Foreign transportation lines, with direct Oriental trade and transpolar routes, will operate to Alaska. Banking will then adjust to direct clearance of foreign items.

The possibilities are endless, and no one can foresee with complete accuracy. However, two conclusions are evident. Alaska will cross the threshold with a forward step—the route and pace are within our control. That is the fascination of Alaska. We are a young country entering into a mature society, and we can help write history instead of merely reading about it.

Where Are the Social Sciences in Alaska?*

MARGARET LANTIS

The author is a graduate of the University of Minnesota and received her Ph.D. in anthropology from the University of California. Her interest in culture stud-ice in Alaska, and also has taught in Aemrican universities. Dr. Lantis has been shown by the variety of her work. She was a teacher for the U.S. Indian Service in Alaska; and also has taught in American universities. Dr. Lantis has been a social analyst for the War Relocation Authority, a social science analyst for the U.S. Department of Agriculture, and a member of the staff for the Study of Lifetime Social Adjustments, at Harvard. At present she is with the Arctic-Desert-Tropic Information Center, Maxwell Air Force Base, Alabama.

SCIENCE CAN BE a way of life, a basic attitude toward the world. Before one can understand the scientist's goals and problems, one must have some understanding of the scientist himself. What is his value-system? What are his functions in society? Since science is not characterized by the things it studies—by its content—but by the way it studies them, the student of social phenomena can be a scientist too, if he lives by the rules. So we can be excused for talking about ourselves for a moment, not as geophysicists or ichthyologists or sociologists but as generic scientists.

The scientist is, first, a person who lives for and in the future. The true scientist is a dreamer, with discipline. His objective is to state generalizations, principles, propositions, tendencies—whatever you want to call them—laws that are bases for prediction. The scientist always must stand the test of prediction. Thus, even though a paleontologist or archeologist is concerned with reconstruction of the past and does not expect to see trilobites or Neanderthal man on earth again, he uses history to formulate principles of anatomic change or cultural change. In other fields the use of prediction is even more obvious and more immediate.

But philosophers and religionists state principles, and everyone predicts. Any person functioning as a scientist is different, however, in: his use of exact methods, his willingness to reveal these methods to others, and his integrity and impersonality in stating his observations. The sin of the scientist is to conceal or to distort. Hence he is (or should be) always conscious that he is standing the test of the future. For this reason we say that he is not merely a dreamer, but a dreamer who has self-discipline. (The man who goes through exact routines and does no more is a technologist, not a scientist.) The scientist constantly seeks new things: new ideas, new methods. He can outdream the advertising and public relations men, but he can only envy—he dare not imitate—the advertising man in his claims. He disciplines himself in formulating exact plans for research. He disciplines himself to be a meticulous observer and recorder, to make careful reports and cautious claims, and to accept criticism when he really wants to call his critic an old fool.

The scientist differs from the layman in another way: he does not only try to see *what* will happen, he also tries to understand *why* it will happen. Hence we further characterize scientists as people with terrific curiosity, always asking "Why?" Members of this Conference know that, as the scientist learns more about the why, the more accurate he becomes in predicting. In Alaska prediction may be especially frustrating and difficult because of extinction of our subjects: owing to rapid changes on this frontier, peoples and animals disappear while we are awaiting for some of our predictions to be proved true or false. But the process is essentially the same in all science.

It seems to me that there are two kinds of work in science; and, to the extent that a person prefers one and uses one more than the other, he is either a watcher or a tinkerer (maybe we can add a third: the fixer); in other words, the natural historian or the experimenter. Both are necessary, and

* Based on an address presented at a general session, September 23, of the Third Alaskan Science Conference, Mt. McKinley National Park, September 22–27, 1952, sponsored by the Alaska Division of the American Association for the Advancement of Science.

both are present throughout the history of any one science. However, in relative numbers, generally the watchers have preceded the tinkerers. They had to look and see what was there before they started working on it. Let us consider biology here in Alaska for an example. Edward William Nelson, whose first big field study was made in the Lower Yukon region 75 years ago (1877–81) and who was Chief of the Biological Survey from 1916 to 1927, contributed to science by his observations and collections in areas never before explored by zoologists. Nelson, Ray, Stoney, and the other men of their period in Alaska did not need many hypotheses and theories. Just to go out and collect was important and sufficient 75 or 50 years ago.

Then the experimental biologist stepped forward. In Alaska during the past fifty years the Biological Survey, the Reindeer Service, and other groups have made field experiments, necessarily uncontrolled in most cases, hence with more hope than prediction. They were very useful, though. Finally came the pathologist. But not until 1948 was the Arctic Health Research Center established. Its work leads us to the real objective of science from a humanistic standpoint: treatment and prevention.

Along another line of development we come to another new institution in Alaska, the Fishery Products Laboratory. We must not forget the Agricultural Experiment Station; but laboratory experimentation in highly specialized fields of zoology and physiology, for example as carried on at the Arctic Research Laboratory at Point Barrow, is recent in Alaska. In these new programs, as in the Coal Analysis Laboratory and the Geophysical Institute at the University of Alaska, the scientists are as usual looking ahead, in application as well as in formulation of theory. In any field we must watch the trends, we must see ahead, not trail after.

Although this is true whether we are studying structure or behavior, it is especially true when we study behavior. Are bogs advancing at the expense of forest, contrary to expectation? At what rate is the Magnetic Pole moving? Are the caribou changing their range? Are the Southeast Alaskans successfully combating tuberculosis while the Central Alaskan Indians are not? Ten years or fifty years from now, one may say, "Well, the caribou used to be here but they aren't anymore." That is, ten or fifty years hence one can say "what" happened but will have difficulty answering the all-important questions "why?" and "how?" It is better to *observe* the rate than to *reconstruct* the rate.

The modern scientist is just the opposite of the popular stereotype, that mentally remote character mounting butterflies and moths on pins and completely unaware that the caterpillars are destroying the orchard. Even if he is not an economic entomologist, the modern scientist, because he is so interested in processes, in the dynamics of life, must be and is a Johnny-on-the-Spot, right there watching the processes as they occur. Consider, for example, the glaciologist who today is probing around in the innards of the glacier trying to find out how long it takes snow to get from the topside to the bottomside and what happens to the crystals on the way down. (May I be forgiven for my phrasing, not being a glaciologist.) People no longer talk about glaciers as just ponderous masses. Laymen would be surprised to hear what glaciologists are doing with their thermistors and other gadgets, and often, of course, they would be dubious about the work if they did know. (This is true of the detailed work of any science.) Glaciologists, however, have it easy. They just talk to other glaciologists or perhaps some physicists and meteorologists. They do not have to ask permission of Old Man Taku (the glacier) to dig around under his skin, as a social scientist would have to do with his subjects.

At last we have mentioned social science. Going from the generic scientist to the specific, let us see what breed is the sociologist. Some people may consider him the Sad Sack among scientists, but let us be charitable and include him in this group of forward-looking men just described. And, let us be sympathetic. Sociology has suffered from both internal and external difficulties. Internally there was too much and too early *emphasis on social pathology*. The curriculum was full of courses labeled Criminology, Social Disorganization, and Problems of Social Welfare. Ecology seemed to become only a study of blighted areas of cities. Lectures on "The Family" dealt chiefly with family disintegration and divorce. Someone has said that among early sociologists in America there were too many ministers' sons who were just trying to talk about sin in scientific terms. All this robbers-and-cops stuff antagonized many laymen, especially civic leaders. The sociologist and several of his fellow social scientists always seemed to show up the worst in the community. Also, just by trying to be disciplined scientists, they often got in bad with the boosters.

Lewis Mumford, the student of city planning and architecture, has said, "It is better to face chaos courageously than to cherish the dream of returning to an outworn synthesis." But of course most people do cling to the old synthesis.

The psychologist has had the same difficulty whenever he got beyond a study of special abilities. In the study of the dynamics of the personality, there was more abnormal than normal psychology; and the layman felt uncomfortable and suspicious. Instead of being reminded how remarkably subtle and clever, yet consistent and strong, is the individual personality, he was made to feel that he was full of irreconcilable conflicts and about to go off his rocker. Fortunately, in sociology, social anthropology, and social psychology the early stage of discovering all the awful things that are wrong with man—his logic-tight compartments, sibling rivalry and Oedipus complex, racial prejudices, and culture lag—has been passed. In psychology now we are hearing about ego strength and ego ideals; in anthropology about the cultural values, that is, the commonly shared beliefs and attitudes that people live by; and in sociology about the processes of achieving consensus or agreement. These topics are not only positive, they are dynamic. The psychologist, for example, wants to know how a youth builds his personal model for conduct. Or, in fancier language, how does he integrate an ego ideal? And so on through a cheerful list of questions.

There are, however, still some difficulties for the development of sociology in Alaska or elsewhere. First, it is very hard to experiment in the field of human relations. We still are in the natural-history stage. At any rate, those of us who make field studies as well as doing armchair theorizing about people and politics are the natural historians of man, trudging up and down the hills of society. Yet we are no longer merely the historians of man, because we now have a much better understanding of scientific problems and of the formulation of hypotheses; and we have more sense in the use of special tools for field study, for example, opinion polls. Although I have not had contact with enough of the other disciplines to be sure of this, it does seem to me that in many fields there is a renascence of good old field observation, a refined natural history done with remarkable new tools. Consider the studies of the stratosphere, of communication among bees and other insects, of the social system of many mammals, for a few examples.

At the annual meeting of the American Psychological Association in Washington, D. C., in September, 1952, Dr. J. M. Hunt in his presidential address urged psychologists to get out of their laboratories and go to "the bank of society" to borrow greater experience and knowledge. He also urged greater collaboration with other professions.

Some of the social scientists also are seeing the value of a well-rounded natural history, not because they went too rapidly and exclusively into experimentation but because they tried prematurely to formulate rigid laws. Economists, for example, have found that economic man is at the same time social man and political man. As Joseph Spigelman pointed out in an article in *Harper's Magazine* ("Can Science Make Sense?" May 1951), the economic system is not autonomous. All sorts of people—businessmen, union leaders, and government administrators—are not letting either prices or wages move according to "economic laws." They want to plan them.

Now we are led to a second difficulty (or a supposed obstacle) in social science: the complexity of human behavior. Actually it is not so complex when compared, for example, with the chemistry of the human body. The biggest difficulty is simply the lack of data, the very small number of scientific observers for such a very big subject. In the United States, for the 600,000 patients in public mental hospitals and for the general population, there are about 7500 psychiatrists, few of whom have time for research on mental health. The Director of the National Mental Health Institute says, "Our minimum need is 15,000."

In my own chief professional society, the American Anthropological Association, there are about 1400 members (not including institutional subscribers), but more than half of these are only subscribers to the journal. Only 600 are Fellows of the Association, that is, professionally trained, professionally functioning anthropologists. In contrast, the current membership of the American Chemical Society, excluding student affiliates, is 67,500. Some of these probably are merely subscribers to *Chemical and Engineering News*; yet, if only one-half are trained active chemists, there are still 33,750. In 1950 a chemist at Merck's plant at Rahway, New Jersey, told me that 90 Ph.D.'s in chemistry were employed there, in addition to all the Masters and Bachelors of Science. As Governor Gruening said, private industry will develop research it is interested in.

On this question of the supposed complexity of man's social behavior, I commend to you George A. Lundberg's article, "Alleged Obstacles to Social Science," in THE SCIENTIFIC MONTHLY, May 1950. Still, it *is* hard at this stage to predict man's social behavior accurately. Nothing so convinces the layman of the value of a science as a few dramatically accurate predictions. Since people in these confusing times need dependable authorities, nothing is

so disconcerting to the layman as the scientist's habit of hedging his predictions. When the responsible social scientist hedges—as he feels he must at this early stage—and talks about variable factors and unknown parameters, the layman decides that he really doesn't know what he is talking about but doesn't want to admit it.

The alternative, which has occurred, is that the political scientist, sociologist, or other social scientist has tried to predict when he did not know enough. He is pressed to do this. Consider how hard it has been to teach patience to the public regarding new therapy of common diseases. The public is slowly learning the caginess of the medical research man and the physician regarding new cures. John Q. Public, however, is impatient for both medical and social wonder drugs. He may feel the kind of frustration an Australian feels when he gets a new boomerang and tries to throw the old one away.

It must be admitted that physical scientists often are as bad as laymen regarding acceptance of new therapeutic methods in the field of human behavior without demanding cautious research and trial. I happened to be traveling about the United States when L. Ron Hubbard's system of treatment for personality ailments was at its height. What did I find? All across the country, many aeronautical engineers, electronics engineers, theoretical physicists, and others in the physical sciences were enthusiastic readers of *Dianetics*. Hubbard had presented a neat system, a special terminology, and other trappings of a scientific theory and a treatment based on it. The system was—shall we say?—premature. We hope no one will expect the social scientist or the psychologist to do what he himself will not do in his own field.

Finally, one big difficulty for the sociologist is definitely not of his own making. It is the sacredness of society to the American. We have progressed so far in medical research that one can divide the children of Houston into two groups, giving half of them gamma-globulin and the other half a placebo; but who would suggest sending half the Houston children to school together regardless of race and segregating the other half, as a social experiment?

Of course, all peoples have similar fears of changing certain parts of their institutions, although the identity of the sacred segments varies. American culture is remarkable in that we have extended scientific methods to one aspect of life after another, much more broadly than most people. Now Americans are taking their stand on the structure

A baby fur seal at the now flourishing rookery on St. Paul Island (U. S. Bureau of Reclamation).

of their social institutions. However, just as public misunderstanding, even hostility, to open discussion of pregnancy and of urinogenital diseases has been overcome, so public consternation at analysis and open talk of social change is being overcome, albeit with bitter skirmishes.

Alaska is much more fortunate than other territorial dependent areas, more fortunate even than the United States in several respects that are interesting to us here. Just when Alaska first feels its need for social studies and first becomes aware of its lack, it happens to be *at the right stage in the development of science* so that it can receive and use the social sciences, and they can do the necessary job. As the president of the Alaska Division (1952), Dr. Laurence Irving, has said, "Location and timing of the events observed can magnify or reduce the value of observations in bringing about the progress of knowledge and thinking."

Where does Alaska fit in the trend of science just reviewed? From atomic physics to social anthropology, *scientists are now interested in processes, in dynamics, in behavior.* No area offers a better opportunity to study social dynamics of a city virtually from the beginning than Anchorage, with its population growing so fast that it is almost a demographic explosion. Social organizations are multiplying all over Alaska. The Territory needs, and should be especially attractive to, people working in basic social science, studying processes of the

formation of a new society. Nowhere do we have enough of basic science in the field of social relations.

There is a *new appreciation of the natural historian, with his interest in the whole habitat,* the ecological community, the "field" and its relationships, which he now studies with improved techniques. This is an aspect of the modern scientist's rejection of autonomous systems, which is happening in all sciences—from astronomy and mechanics to neurology and economics. Today we may be floundering a bit in our study of interrelationships in a total field, but we probably are nearing a new organization of knowledge.

Alaskan communities, although growing, are not yet too large or too suburban to be studied very profitably as functional entities. Whether the communities and clubs and customs are just starting or are dying (as some Alaskan villages are), the interrelationships throughout the Territory and between it and the States can be studied. For one thing, migration into and out of the Territory can be ascertained more exactly than in any single state. We have, then, a manageable field for study.

Every real scientist accepts the necessity of prediction. How Alaska needs scientific prediction! If it is not to become a neglected social and political jungle, it needs not only the field observer, not only the basic scientist phrasing concepts and hypotheses; it needs also the man who will apply the generalizations to specific cases. Once the schools and other institutions are built in the wrong places for a changing population, once an agency unequipped to perform a certain duty is given that duty, both employees and users of the institution always suffer when a change must be made because there was poor planning or no planning. Everyone suffers from the malfunctioning of social institutions, and some people suffer from the change that must be made. The social scientist may be unwilling to commit himself on a prediction or he may make a mistake when he does commit himself; nevertheless we need him so much that we can risk giving him a chance at the job.

It is not merely because Alaska is growing that we must train and encourage social scientists for it. One good reason is that Alaska has, so far as I can discover, no sociologists—at any rate, none free to do research—and very few other social scientists. The Alaska Division of the AAAS has to ask an anthropologist to talk about and speak for the sociologists. The University of Alaska, whose president is aware of the need and wants to do something about it, has not yet been able to offer courses in sociology except two given rather apologetically by an anthropologist. At a conference on Alaska's resources, held in the Department of the Interior just a few years ago, the original program included everything from clams to hydroelectric potential, except of course its people. (Fortunately, one man in the Department, seeing this omission, insisted on talking about native Alaskans as an important resource.) The founders of the Arctic Intstitute of North America, the only sizable and international foundation devoted to research on the American Arctic, originally proposed to sponsor work in the social sciences as well as physical and biological sciences, but one founder objected and the social sciences were deleted from its charter. Increasingly, however, the Institute has supported anthropological research that is very close to sociology.

The Geological Survey had more than 40 field parties working in Alaska during the summer of 1952. The Fish and Wildlife Service had about 150 people in the field. And there are related Territorial agencies. In contrast, there is no research agency (excepting the specific field of public health) comparable with the Geological Survey to study the most important animal of all, man himself. The Geological Survey is studying the processes of solifluction and the boundaries of permafrost. No one is studying the vigorously contending processes of competition and cooperation in these new communities. No one is studying the shifting boundaries between private development of a new area and governmental development. Because of the recently expanded work of geologists and engineers in the North, the engineers can build better on permafrost. In contrast, no one is learning how to handle the processes of competition and cooperation so that there will not be a frost heave in the community every summer when migratory workers—the miners or cannery workers or construction workers—come in.

I do not want to make the geologists and zoologists feel guilty. They have no reason to feel guilty, but they should feel lucky. A scientific discipline's usefulness depends not only on its ability to do the necessary job but also on its being given the opportunity to work. The geologists have been given, or have fought for and won, that opportunity. Now the social scientists need their chance.

Social research is not completely lacking in Alaska. With the generous help of Alaskans I have compiled a list of fourteen projects (1948–52). It is noticeable that economists and anthropologists are doing the most in social research here. Five of

the fourteen studies are wholly or largely economic. Five have been made by anthropologists. The remaining four are divided among the fields of public administration, sociology, and mental health research. Although Alaska has housing specialists, trained social workers, and a specialist in vocational rehabilitation, only one professional sociologist (so far as I could ascertain) has worked here—on a summer's field trip. Social scientists must take part of the blame for their absence from Alaska: they should see what an opportunity it offers! And part of the blame rests with Alaska.

Every frontier region has to reach a certain stage of social organization before it can support professional specialization. Each of the American frontiers in succession seems to have gone through similar stages. To illustrate where Alaska now stands in this development sequence, let us paraphrase the terminology of our friends, the American archeologists, especially those who study the cultures of the Southwest. Using styles of pottery to designate the stages within each culture period and area, they have given the periods names like Black-on-red I, II, and III or Red-on-buff I, II, III, and IV.

For Alaska let us take music instead of pottery. As a somewhat undisciplined dreamer with one eye shut, I am going to call the first period Kobuk Maiden I to XII. To cheechakos we must explain that "The Kobuk Maiden" is an Alaskan ballad, of which there must be at least twelve versions. In frontier anarchy, when cultures meet and races meet, human association is spontaneous. The community does not sponsor any national chess tournaments. People dance, sing, play cards, or pray with different participants every week and usually with any participants who want to join in. There are only a few very basic organizations, and they also apply to or are open to all: enough town government to try to keep law and order, material services such as general store or the garage and later the water district or the toll road, and some religious services. Men band together to form a posse or a search party for a downed plane, to bring in a wagon-train of supplies or a plane with penicillin. They talk about independence and self-reliance out there on the frontier, but they join together very freely. And they sing doleful ballads of their difficulties, also spontaneously and anonymously. Fortunately, to most people "The Kobuk Maiden" is anonymous.

Then comes the second period: John Philip Sousa I to ?. People then talk much more about their common interests, while they are busily setting up organizations for their particular interests. Parents' groups, the Grange or Farm Bureau, the singing society (possibly even called a Choral Group), the whist or bridge club, and especially the businessmen's organizations. Probably the first professional or quasi-professional group is the Historical Society. People, seeing the rapid changes on a frontier, become aware of history and of their individual place in the history of their particular community. So they enjoy pageants and memorial ceremonies; they join the town band and play John Philip Sousa.

Finally, there is the Bach and Boogie Period, which Alaska is just entering. The bawling balladers have now become the Madrigal Singers or perhaps a Chamber Music Group. There will be later a variant: the Chamber Music Society of Lower Basin Street. In this period there is less talk of common interests, although there are more and larger organizations. It is recognized seriously that everyone has special interests. There are flying clubs, and the Culinary Workers' Union, and neighborhood associations, and the Society of Dental Technicians. As a local example, this year (1952) the Alaska Nurses' Association was organized and held its first annual convention. Alaska needs all kinds of specialists and associations of specialists and is gradually getting them.

Alaska offers as wonderful opportunities to the sociologist or social psychologist as to the archeologist, who here finds ancient cultures beautifully kept on ice. Alaska contains nearly all the stages of modern American culture, not on ice but—better still—decidedly viable and excitable. Some of its people have not forgotten, nor yet got to the stage of "reviving," The Kobuk Maiden while other Alaskans are singing the great religious chorales. The Territory seems to have very little dead wood in its society and fewer dominating vested interests than it formerly had.

We have seen that the social sciences are at the right stage of development to make a constructive study of an area like this. Now we can add that Alaska is at the right stage of general cultural development to accept professional social study of itself. We must not deceive ourselves into believing that on the one hand there will be no public opposition to social science in Alaska or on the other hand that there will not be inadequate work by the social scientists. I am hopeful, however.

At Alaska's present stage of readiness, perhaps it only wants to know how big and great it is becoming. Perhaps it only wants to know how many robbers it has, in order to decide how many cops to ask for. However, as one federal administrator

pointed out to me, there have been too many studies of this kind without anyone ever having enough power to get those policemen that the Territory knows it needs.

I agree that such counting of heads is not enough. Instead of merely surveying the social pathology of the Territory or of surveying anything, we want to study dynamic processes, just as the geologist and botanist study the forming of soil polygons in the tundra. Although Alaska is not the only new society and new economy that might be studied and even though many processes at work here may have been observed elsewhere, it does offer a fine new opportunity that should not be missed. Probably volcanologists did not make any stupendous discoveries from Paracutin, but some of them managed to get to that cornfield where a little volcano was sprouting.

I probably have talked too much in generalizations. Although we do not have time here to outline specific research projects for Alaska, let us bring this discussion closer to earth at the close. What *should* we study here in Alaska? I can give one example most clearly by telling what I think is the socio-economic trend of Alaska's development, hence what we must know in order to accommodate that trend, to adjust to it.

Agriculture will increase in a few parts of Alaska, but here, as in Norway and Sweden, mines, manufactures, and fisheries will support a growing population and economy far better than agriculture. We cannot ignore Alaska's topography. A non-agricultural region can be economically useful in three ways: production of raw materials (minerals, oil, timber); processing and manufacturing; provision of services, including trade. Alaskan economy can be stabilized by varied manufacturing and processing, especially processing. People forget that the basis of Southeast Alaskan economy for 75 years has been a processing industry, seafood canning. For the Territory as a whole, the economy has been based almost exclusively on exploitation of natural resources: fur-bearing and oil-bearing animals, fish, minerals, and, to a small extent, timber. With the exception of fish, virtually all products were shipped out unprocessed.

Now that the Alaskan economy is getting its new start by means of a construction boom and will have many construction needs for a long time, the first requirements are for local processing plants to provide construction materials (cement, lumber, aluminum) as well as such plants as pulp mills to process materials for export; power to run the plants; local skilled labor; the service trades. Getting out *raw* materials with modern technology means few men and a lot of heavy equipment. Processing plants and especially the service facilities, on the other hand, require workers. A particular type of economy facilitates or even requires a particular type of society and perhaps of political organiation. We do not know nearly enough about the relations between economy, society, and politics; and Alaska is just the place to study them.

In the present condition of Alaska and in the economy that it seems to be getting, we must study three dynamic relationships: the people and their material resources; the people who are coming here and the new socio-economic system they are building; the people and their Territorial political system, a survival from another era. Together they would provide an example of ecology in its largest sense and an exceptional opportunity for the study of process: migration, diffusion of culture, selection, adaptation, inner adjustment, invention. *The equipment that new settlers and native residents bring to the new society are as important as the country that receives it,* especially the ideas that individuals live by: their unstated assumptions, their expectations, their struggles to get what they want, in a job or a place in the community or a government protection. We call these "cultural values." To learn about them, one does not simply distribute a questionnaire. This is a task for professionals, and a tough one even for them.

After one has dreamed in large concepts for a while, the old self-discipline starts functioning. So we study this village and that union. carefully and in context. Then we compare the value systems of different groups. Then what happens? We find that we now understand some of the bases of people's attitudes toward each other. We see much more clearly the common assumptions, the common ideals at work in a community, and the subtle differences. We see how different people can get self-respect and a feeling of well-being in very different ways. To struggle for self-esteem is to be human. To struggle in a particular way is to belong to a particular culture and society.

To make life more satisfactory for Alaskans, one must study Alaska. And in understanding the processes of behavior in any group, one understands more about mankind and contributes to basic science.

Circumetrics

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Also he made a molten sea of ten cubits from brim to brim, round in compass, and five cubits the height thereof; and a line of thirty cubits did compass it about.——II Chron. iv: 2

VENTURE a hop, a skip, and a jump into the enchanted labyrinth of mathematics, and you encounter, not a monster, but a protean character of numerous and subtle disguises. It may appear the integral of $(1+x^2)^{-1}dx$, may turn up as the square of the gamma function of one-half, or be revealed as the number of i's in the natural logarithm of minus one. And even if you decline to have truck with such high-falutin appearances, you can hardly withhold friendly recognition of its best known, although far from most characteristic, garb, one that has endowed it with a practical interest having a documented history of four millenia, and a record beyond compare of man-hours of devotion by the geniuses, the norms and the cranks of half-a-dozen civilizations round the globe. For our Proteus is also the measure of the circumference of a circle in terms of its diameter, known in modern times as π (symbolizing perimeter).

In the beginning[1-6] the problem of estimating π was often cast in the allied form of squaring the circle, the Rhind Papyrus of about 1700 B.C. providing us with a perfect example in A'h Mosé's injunction to "cut one-ninth off the diameter and construct a square on it; its area will be equal to that of the circle." In other words π is there declared to be $(4/3)^4$ or 3.1605, a most respectable value—one that is way ahead, not only of Solomon's unwisdomly three, but, more impressively, of the approximations used by competent Roman engineers some sixty generations later. Meanwhile, the Greeks, geometers *pur sang,* had pondered the question; Archimedes, working with polygons up to 96-sided, laid down upper and lower limits of 22/7 and 223/71. Ptolemy's value was 3° 8′ 30″, which is 3.1417. This represents an error of roughly 25 parts per million, equivalent to about two-thirds of a mile in the circumference of the earth, and it prompts the question of why, if a tolerance good enough for a twentieth century precision machinist was achieved in second century Alexandria—why has its ultra-refinement been so zealously pursued through the ages that followed? An adequate answer could not be attempted here; it is too complex; but it may be noted that the question is bound up with the scholastic interregnum of the Dark Ages, with the weaknesses of communications, with the belief that π was a sort of philosopher's stone of mathematics, and even with the spirit that sends men to the toil of Mount Everest. The interregnum meant a virtual cessation of π-work in the West for roughly 1000 years; and the communication weaknesses linked up with the formidable linguistic differences between cultures that obscured from us, until comparatively recently, the pi-istic contributions of the Far East. Additionally, the all too common Asiatic inclination to fuse science and Holy Writ, and the twisting of expression to meet the demands of versification—especially in India—combined to fuzz the picture. Today however there is a bulky literature on the topic from which we cannot fairly omit to mention one or two highlights. For example, in A.D. 479, Tau Tung Chih put forward the fraction 355/113, which is correct to six decimal places (and which was exported to Japan, and was to turn up in sixteenth century Europe in the writings of Otho and Metius). A hundred years later Arya Bhata the Elder's work with polygons led to the recipe "Add 4 to 100, multiply by 8, add 62,000, and the result is the circumference of a circle of diameter 20,000," which implies a π of 3.1416. In both India and China, as well as in certain European centers, there have been advocates of $\pi = \sqrt{10}$, and it is perhaps surprising that the obvious appeal of this value has not had more success—especially among circle squarers.

Pervading much early speculation and measurement is the belief that that π is a rational quantity, i.e., that it can be exactly rendered as a vulgar fraction. The Greeks were fully aware of the concept

of irrational quantities, *teste* Pythagoras's celebrated proof of the irrationality of $\sqrt{2}$, but it was not until 1761 that π was put into that category by Lambert (and thirty-three years later Legendre made the important extension to π^2). And even those who felt in their bones that a simple fraction was unrealizable could not be blamed for putting their money on some not too cumbrous expression that would be π. Such as, for instance, Kochansky's $\sqrt{4+(3-\sqrt{1/3})^2}$ yielding 3.14153, and Specht's $1/10^7+\sqrt{(146)}\times 13/50$ in 1808, which is correct to 14 decimals! In 1882 Lindemann settled once and for all the kind of number that π is by a brilliant proof of its being transcendental, thus giving the congé to all attempts to square the circle geometrically. Almost needless to say, no circle squarer worth his mettle was deterred by the Great Event of 1882 (any more than he had been by the significant and forward-looking resolution of the French Academy of Science, a hundred years earlier, not to accept any more papers on the subject). Indeed, as we shall see in a moment, at least one later champion carried his banner with the strange device to august and unlikely places.

But to go back: an important transition in pi-valuation took place during the Renaissance, namely, the replacement of polygonning by the setting up of infinite series that could be calculated to whatever degree of accuracy a man cared to give his time. Probably the first formulation was Vieta's

$$\frac{2}{\pi}=\frac{\sqrt{2}}{2}\,\frac{\sqrt{(2+\sqrt{2})}}{2}\,\frac{\sqrt{[2+\sqrt{(2+\sqrt{2})}]}}{2}\,\ldots$$

in 1597. Nevertheless, polygon devotees throve for long enough afterwards. Ludolph van Ceulen, for example, began, about the time of Vieta's discovery, to lay aside all other activities to make piiferous polygonning a full-time occupation. By the turn of the century he had established 20 decimal places; when he died in 1610 the number was 35, which value of π was inscribed on his tombstone at Leyden; and apparently π is still sometimes called the Ludolphian Number by German-speaking peoples. In 1630 Grienberger published the 39 places of π he had sweated out using a simpler process than van Ceulen's. His was the last effort of note, although constructional polygonning as an indoor sport continued, and late in the nineteenth century a dedicated German devoted ten years to inscription of the fifth and last prime-sided polygon of Gauss's series; the resultant 65,537-sided figure lies today in the archives of Göttingen, a wondrous monument to human diligence. The seventeenth century witnessed the development of convergent infinite series and fractions: Gregory and Leibniz evolved the series

$$\pi/4=1/(2+3^2/(2+5^2/(2+7^2/(2+9^2\ \ldots$$

that was later to become the basis of modern rapidly converging series, although it is itself arithmetically exasperating when x is put equal to unity for the equality of $\pi/4$. Then the Englishman Wallis turned up with the remarkable formula that may be stated: $\pi/2$ is the product of the infinitude of terms $n^2/(n^2-1)$, where the n's are the even integers. Incidentally, en route to this expression Wallis concentrated on the area of the quadrant and found himself building up a series that cried out for the method of interpolation—for which he had no tools. So he appealed to Newton whose solution of the problem led to his evolving the Binomial Theorem. This is one of several examples of the insemination of other departments of mathematics by pi-ists. At about the same time Wallis's contemporary and correspondent, Lord Brouncker, worried out what was then a new kind of expression, namely,

$$\pi/4=1/(2+3^2/(2+5^2/(2+7^2/(2+9^2\ \ldots$$

and thereby initiated the study of continued fractions.

In the year before the century ended, Abraham Sharp, working under the direction of Halley and using the Gregory-Leibniz series, evaluated π to 72 places, only one of which was subsequently found to be incorrect. In 1706 a derivative of the same series was used by Machin to compute π to 100 places, and his formula,

$$\pi/4=\text{arccot }1=4\text{ arccot }5-\text{arccot }239$$

was to become famous—and has never really been bettered. It is, as a matter of fact, one of innumerable "arccot splits" that can be used to compute π, and over thirty of them are to be found in the literature. Among notable ones is Strassnitzky's arccot 2 + arccot 5 + arccot 8 with which Zacharias Dase, a sort of animated Eniac in the employ of Gauss, calculated π to 200 places in 1844. This was early in an era that can almost be described as one of furious competition among European pi-makers. Three years earlier Rutherford had computed π to 208 places (of which, however, the final 56 were in error) with an arccot-split given by Euler; and he eventually built up 440 correct places (1853). Meanwhile, in 1847, Clausen, reverting to Machin's formula, had published a 205D value, correct to 200D. Then Richter published 330D, of which 300 were correct, in 1853.

and in the following two years he pushed on to the 500th place. In this he was just behind the Englishman William Shanks, who hit the jackpot with a 530D value via the Machin formula. But not content with so small an edge over his rivals, Shanks pressed on to reach apogee in 1873 with the 707th decimal. This singular triumph was to remain peerless and unchallenged until post World War II; no doubt it was felt that pi-valuation, like Rodgers' Kansas City, had gone about as fur as it could go, and in a book revised as recently as 1945 can be found the statement that anyone wishing to reach the 1000th place must be prepared to devote ten years to the job. The writer must momentarily have forgotten that he was living in the electronic age. Incidentally, although the several computors' values up to 500 or so decimals provided cross checks, the higher Shanksian figures could not be anchored to any such source of confidence. The 707D has been constantly quoted over the years despite the early discovery of the suspicious circumstance that the distribution of the digits was not random, and that there was a deficiency of 7's.

We now move to the ancient English city of Chester where, quite recently, pi-ist Ferguson, using the formula

$$\operatorname{arccot} 1 = 3 \operatorname{arccot} 4 + \operatorname{arccot} 20 + \operatorname{arccot} 1985$$

attributed to a colleague, although in fact to be found in a Victorian textbook, began to build up π anew, and in 1946 was able to announce that Shanks's 528th decimal, and hence every subsequent one, was wrong.[7] Meanwhile Smith and Wrench, of Georgia and Washington, D. C., working with Machin's old formula, were doing the same chore; they confirmed the Shanks breakdown point, but did not wholly agree with Ferguson's amendments.[8] There followed a period of Transatlantic error-swapping that prefaced a Ferguson-Wrench collaboration that really got the bugs out of the high decimals and enabled them to publish a cross-checked value to 808D in 1948.[9, 10]

And now a formidable group begins to paw the pi-ous ground namely, the ENIAC workers.[11, 12] Three of them, Reitwiesner, Neumann, and Metropolis, began by weighing the relative convenience to eniackery of three arccot-split formulas, including Machin's, the one Ferguson had used, and another. The first-named, they decided, was best suited to the *modus operandi* of the computing machinery. Having carefully programmed the work, they chose the long week-end that included Labor Day, 1949, to carry out the job without interfering with ENIAC's routine work. Four operators worked eight-hour shifts, night and day, putting in a total of seventy man-hours, and emerged, pale-eyed but happy, with π to an elaborately checked 2035D. Subsequently, the digits (which, incidentally, confirmed the Ferguson-Wrench sequence) were thoroughly tested for randomicity and came through with flying colors. Only the irredeemably soulless will not take off his metaphorical hat to the heroes of that memorable week-end.

In pursuit of the main flight of pi-ists we have necessarily had to leave behind an interesting side flight and the lunatic fringe; to these we must now return. The side flight is probabilistic π, quite a subject in itself: it is concerned with the making of trials of various possible conjunctions such as the random selection of pairs of prime numbers that are prime to each other, or the random contact of regular objects, whose probabilities are expressible as formulas that contain the number π. Thus Chartres, in 1904, made a random selection of 250 pairs of primes and found that 154 of them were prime to each other; and as it is known that the probability of the conjunction is $6/\pi^2$, his trial amounted to an estimate of π of 3.12. A trick that has been attracting spasmodic attention ever since its first presentation by Buffon (yes, the naturalist!) rests on this proposition: In repeated throws of a stick of length d (less than unity) onto a grill of parallel lines unit distance apart, the fractional frequency of hits will tend to $2d/\pi$. Several results of π-estimations by this means are on record, the most spectacular being by Lazzerini in 1901 who made 3408 throws to produce a value of 3.1415929, an apparent error of one part in ten millions! Unfortunately it is not difficult to show that this and some other impressive results are too good to be true; they are not "estimates" at all, and must have depended heavily on the experimenters' preconceptions. Mechanized versions of Buffon's device have been used in science exhibitions to interest visitors in helping build up an estimate of π by operating it themselves.

A comparable proposition regarding the dropping of a sphere onto a plate in which circular holes (of larger diameter than the sphere) have been cut in a regular pattern, is as follows: The frequency of clear throughfalls tends to $2\pi/\sqrt{3}\, k^2$, where k is a function of the dimensions. The notable feature of this device is its having been tested with extraordinary thoroughness by Clarke in the early 1930's. He recorded no fewer than 250,000 falls of a ball-bearing onto a machined steel plate and arranged for the contacts to be electrical and to

produce a headphone click.[13, 14] His final best estimate of π was 3.143.

What I have called the lunatic fringe is the habitat of the circle-squarers, mostly those perfervid souls who, in effect, feel divinely convinced that π must be a simple number on the ground that God would hardly permit so important a value to be incommensurable. They come from all classes in every country. Even Thomas Hobbes, whose sanity was positively awesome, and who would scorn to invoke His geometry, hotly insisted, in his *De Problematis Physicus*, that π must be 16/5, and he wrote the most scarifying tracts against Wallis and his more orthodox views. Joseph Scaliger, the great Latinist, fell victim, and many were influenced by his authority. Your true pi-man, by the way, is rarely a Simple Simon; as like as not he will also be a pyramidologist, or a perpetual motioner, or a carrots-and-sex regimer, or a flat-earther (although the ranks of the last-named have thinned pitifully in recent years) into the bargain. We may instance Henry Sullaman who found that the Number of the Beast, 666, was the key to the problem. Then there was de Causans, a French Guardsman who, according to de Morgan, "cut a circular piece of turf, squared it, and deduced original sin and the Trinity." It is to de Morgan's delightful book, *A Budget of Paradoxes*, that we owe much entertaining information about that prince of circle-squarers, James Smith of Liverpool, who, in the 1850's and 1860's, devoted an incredible amount of time, energy, and paper to his contention that $\pi = 3\frac{1}{8}$. He would send de Morgan enormous letters, sometimes several in a week, to try to convert the errant mathematician; and he generally exhibited all the symptoms of what de Morgan called *morbus cyclometricus*. In connexion with the seemingly endless dance he was led by the contemporary circle-squarers, de Morgan once declared that their patron saint should be St. Vitus.

It is sad that de Morgan did not live to appreciate the wondrous things that were later to happen in the Middle West.[15] In 1889, Dr. Goodwin, a medical man of Solitude, Indiana, copyrighted the following statement: "A circular area is equal to the square on a line equal to the quadrant of the circumference; and the area of a square is equal to the area of the circle whose circumference is equal to the perimeter of the square." Later he published an article *in an orthodox mathematical journal* on the "The Quadrature of the Circle," the opening paragraph being the copyrighted statement given above and that thereafter drivelled on to "prove" that $\pi = 16/5$ by a method that involves, by implication, the identity $7^2 = 50$. The article was published "at the request of the author" and is significantly never referred to in the lively discussion columns of subsequent issues. Dr. Goodwin made good use of that publication; it enabled him to claim that his quadrature was "accepted as a contribution to scientific thought" by the journal, a claim that was prominent in the taking of his next step. On January 18, 1897, Goodwin's county representative introduced House Bill No. 246 into the Indiana State Legislature; it began:

> A bill for an act introducing a new mathematical truth and offered as a contribution to education to be used only by the State of Indiana free of cost by paying any royalties whatever on the same, provided it is accepted and adopted by the official action of the legislature of 1897.
>
> Section 1. Be it enacted by the General Assembly of the State of Indiana: It has been found that a circular area is to the square on a line equal to the quadrant of the circumference, as the area of an equilateral rectangle is to the square on one side. Etc., etc., etc.

The worthy Representatives, finding that they would be able to collect royalties from the willing scholastic converts beyond their borders, routed the bill through the Committee on Canals (*sic*) then through the Education Committee, both of whom approved it, and on February 2 the House voted its acceptance by 67 to 0. It then went to the Senate who thoughtfully referred it to the Committee on Temperance, which, evidently convinced that it did not endanger the sobriety of Indiana's residents, promptly passed it. By this time, however, the Indianapolis press had got hold of the story, and it began to spread across country. Just in time the Senate woke up to the enormity of the gaffe it was about to commit, and on February 11, House Bill No. 246 was postponed indefinitely. So fell the curtain on what is surely one of the most fantastic scenes in the history of both pi-istics and legislature.

A myth of peculiar virility in the busy world of circle squarers is The Reward, a princely sum alleged to have been set aside, usually by a government, and mostly that of France, for the long-sought solver of the "problem" and, *ipso facto*, benefactor of mankind. The last century saw the high-water mark of would-be applicants; now they are pretty rare. But not extinct; only a few years ago access was gained—indeed, almost forced—to the study of a well-known Canadian scientist by a tense little man who held him with his glittering eye, announced with suppressed passions that he had just squared the circle, and please would the doctor tell him how to set about collecting The Reward? The scientist gently assured his visitor

that he would have to be content with the laurels of success finely won, and, -er, perhaps he would demonstrate his achievement? The little man rose in silence, cast over the desk a look in which was mingled impatience, scorn, and a cagey I-know-a-con-man-when-I-see-one, and swept out. From his window the scientist watched with emotion the last proud standard bearer of St. Vitus hurry round the block into a street where, come to think of it, the French Consulate happened to be. Did I, foolishly, say *last*? No, no; doubtless, someone, somewhere, at this very moment. . . .

References

1. DE MORGAN, A. *A Budget of Paradoxes.* London: Longman Green (1872).
2. CAJORI, F. *A History of Mathematics.* New York: Macmillan (1926).
3. ———. *A History of Mathematical Notation.* Chicago: Open Court Publishing Co. (1928).
4. BALL, W. W. R., and COXETER, H. S. M. *Mathematical Recreations & Essays.* London: Macmillan (1892–1947).
5. KASNER, E., and NEWMAN, J. *Mathematics and The Imagination.* New York: Simon & Schuster (1940–45).
6. MCKAY, H. *The World of Numbers.* New York: Macmillan (1946).
7. FERGUSON, D. F. *Nature,* **157,** 342 (1946).
8. ARCHIBALD, R. C. *Mathematical Tables and Aids to Calculation,* **2,** 143 (1946–47).
9. FERGUSON, D. F., SMITH, L. B., and WRENCH, J. W., JR. *Ibid.,* 245.
10. FERGUSON, D. F., and WRENCH, J. W., JR., *Ibid.,* **3,** 18 (1948–49).
11. REITWIESNER, G. W. *Ibid.,* **4,** 11 (1950).
12. METROPOLIS, N. C., REITWIESNER, G. W. and VON NEUMANN, J. *Ibid.,* 109.
13. CLARKE, A. L. *Can. J. Research,* **9,** 402 (1933).
14. *Ibid.,* **11,** 658 (1934).
15. EDINGTON, W. E. *Proc. Indiana Acad. Sci.,* **45,** 206 (1935).

RUBY

Now as the sun incarnadines the West
This stone reflects it in a sea of flame;
The children of July proclaim it best,
And ruby, or red sapphire, is its name.
Here is a gem to fan the heart's desire;
In times gone by an Emperor of Cathay
Illumed a golden chamber with its fire;
It lit a god's abode, so legends say.

Fabulous stone, to match the "pigeon's blood,"
Yet clear, transparent, held against the light,
Red, red, and red again, and still more red,
Its brilliance penetrates the darkest night;
Here are the carmine rose, the velvet bud,
And poppies growing, cardinals in flight.

MAE WINKLER GOODMAN

Cleveland, Ohio

Mapping Water-Saturated Sediments by Sonic Methods*

W. O. SMITH and HERBERT B. NICHOLS†

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COMPLETION OF OCEANOGRAPHIC STUDIES in the Bay of Fundy for the Corps of Engineers, U. S. Army, makes it appropriate to look back over the progressive stages whereby a new technique was developed for geophysical investigations. This new method is based upon the speed with which sound waves of very low frequency penetrate water-saturated unconsolidated sediments.

The basic instrumentation is operated on the sonar (echo) principle, using a sonic signal given off by what is known as a "transducer." This is comparable to a radio station transmitter, of greater delicacy than a fine, jeweled watch and many times more expensive. In the working position the transducer is slung out over the side of the vessel from a davit. Essentially it consists of a metal and rubber container with carefully polished crystals, some of which change outgoing electrical impulses into sound waves as they head bottomward. Other crystals on the receiving end retranslate the returning echoes into electrical impulses which can be amplified and made to write their own record of underwater travels.

To date, such sonic methods have been successfully used to provide data on the approximate useful life of Lake Mead as a reservoir for water supply and power production; to supply the City of Chicago with a map of bedrock contours offshore under Lake Michigan along the route of its proposed $85,000,000 water tunnel; and, most recently, to outline for the Army Engineers the bottom conditions likely to influence location of engineering structures at the mouths of Passamaquoddy and Cobscook bays, should it ever be decided to develop tidal power in this area. (See paper by W. O. Smith in *Am. Inst. Mining Engrs.*, in press 1953). There is evidence, too, that this same technique can be applied to measuring the capacity of large underground aquifers, particularly where the water table is not far beneath the surface of the ground.

For all this work the penetration of sound through sediments has been the basic yardstick. In the past there has been considerable uncertainty regarding the conditions under which sound will penetrate sediments, and doubt had been expressed that it would do so at all. These doubts have been dispelled through basic studies by the Geological Survey during the past several years, studies accomplished in close cooperation with the Navy Department.

First it is essential to recognize that the nature of sediments plays a dominant and often complicated part in their acoustic response. Sediments may consist of gravel, sand, silt, and clay in various proportions. Organic matter also is often present. Clays are, in general, plastic and present many complications. The importance of differentiation in sediments becomes apparent as investigations progress; and the physical conditions, especially as they relate to water content, are likewise important.

The Lake Mead Problem

Thus far all the Survey investigations have been concerned with saturated sediments overlaid by

* Publication authorized by the Director, U. S. Geological Survey.

† The authors wish to acknowledge the assistance of G. B. Cummings, formerly of the Bureau of Ships, Navy Department.

water, the depths ranging from a few feet to several hundred. The first observations on sound penetration in sediments were made at Lake Mead during 1948–49. The Bureau of Reclamation had encountered certain major problems in the operation of Lake Mead, the storage reservoir behind Hoover Dam, and had requested Survey assistance to determine the precise capacity of the reservoir and the rate at which sediment is accumulating and to give a good estimate as to the probable life of the reservoir.

Inasmuch as fairly accurate photo maps existed showing the terrain prior to construction of Hoover Dam, it was surmised that the sonic method could be used extensively in obtaining the needed data. The Secretary of the Interior requested assistance from the Navy Department. At first it was thought that Navy sonar equipment and personnel to operate it would be sufficient. But the problems introduced and the possibilities that developed were so far reaching that before the work was completed assistance rendered to the Survey included that from the Bureau of Ships, the Navy Electronics Laboratory, and the Bureau of Ordnance. The Scripps Institute of Oceanography also gave considerable aid.

Two years were required to plan the operations, assemble equipment, gather comprehensive data, and accomplish the necessary interpretations. Since the mapping of lake sediments required an accurate reference system to which all soundings could be referred, a third-order control net was established by geodetic engineers of the Geological Survey. The triangulation net as established consisted of a series of accurately located reference marks around the lakeshore. There were 307 such shoreline marks and 27 additional triangulation stations which tied the various surveys together and connected with base points of the U. S. Coast and Geodetic Survey. By taking sights to the shore stations, hydrographers out on the lake could locate themselves accurately when making soundings, taking samples of silt, or making other observations. Lake Mead is roughly a large Y in shape, with its base at Hoover Dam in Black Canyon. The north fork is the submerged river channel of the Virgin River; the south is the submerged Colorado.

Primarily the problem was to find out how much mud, silt, and sand had been dumped into the lake since the waters backed up to spillway level. Water and sediment accumulating in the lake come from a region extending far beyond the limits of the area studied. This extended area includes some 168,000 square miles, or roughly 5 per cent of the continental United States. The original plans called for the delineation of the top of the sediment by sonic soundings using standard Navy depth-finding equipment. Such instruments project sound waves downward from the surface and automatically translate into fathoms of depth the length of time it takes such waves to strike bottom and be reflected back to the instrument. The bottom of the sediment was to be determined from the topographic survey made by the Fairchild Aerial Survey just before the lake was filled. The difference would be the sediment thickness.

It was soon discovered that under certain conditions the existing sediments were easily penetrated by sound. A frequency of the order of 50 kilocycles did not penetrate except under certain conditions, but a lower frequency of 15 kilocycles did go through regularly when the sediments were of medium consistency. This generally meant fine silt and clay having a water content of 40 to 50 per cent.

An examination of a typical sonic profile taken 20 miles above Hoover Dam revealed some 80 feet of distinct sediment deposits produced by density flows, and the rock bottom of the old river channel was easily distinguished. Coring showed that these sediments were not very compact. Inasmuch as a complete topographic survey of the entire Lake Mead area had been made before the lake filled (therefore at a time when it contained no sediments), an excellent opportunity was afforded to compare the original bottom as disclosed by sound penetration with that actually known to exist.

With the exception of a small amount of sediment contributed at four places by slumping of the reservoir walls and by the precipitation of silica and calcium carbonate rock-forming materials carried in solution in the lake water, all the sediments of two great deltas, extending downward from the original head of the reservoir to Hoover Dam along the former river channels, had been supplied by the Colorado and the Virgin rivers systems.

Slightly more than 2 billion tons of sediment was found to have accumulated in Lake Mead. This material now occupies about 5 per cent of the reservoir storage capacity below the spillway level. From figures on the rate of sedimentation, the rate of sediment compaction, and the capacity of the reservoir for storing sediment above the lake level, the now generally accepted estimate of the time required for the reservoir to become filled was computed, assuming that the rate of sedimentation continues as at present. Plotting the mean elevation of the sand deposits and the finer silts and clay as two separate curves projected against time, it was found that they intersect at a point

445 years from the date Hoover Dam was completed, or at about A. D. 2380.

The Chicago Problem

At Chicago the situation was somewhat different, but the main problem again was to measure sediment thickness, determining the depth to bedrock along a 5-mile segment of the lakefront. It is planned to construct a new $85,000,000 Central District filtration plant and distribution tunnel north of Navy Pier to provide additional potable water from Lake Michigan. The present South Side Pumping Purification Plant is already the largest in the world, but the new one will be three times larger. It was important to know beforehand the configuration of bedrock along the proposed route, because for efficient construction and operation the tunnel must be cut about 50 feet below the top of the limestone bedrock.

A preliminary study of existing cores from the area showed that the Lake Mead equipment would not be suitable. It had neither the power nor a sufficiently low frequency to penetrate existing sediments. However, the Navy Department had just developed depth-finding equipment of much greater power, operating at a frequency of 11 kilocycles. With this equipment the Survey researchers felt that they had a fair chance of penetrating the Lake Michigan sediments to reach bedrock.

Sound profiles were obtained over an area about 3 miles wide extending from Navy Pier to Montrose Harbor. Sound velocities were determined from sound traces taken over existing cores. Known cores were thus relied upon for control, core depths being correlated with the corresponding time of traverse required for sound to travel the length of a given core. As was expected, geophysical interpretation of the sound traces also required geologic control. This was obtained from the numerous borings in the Chicago area, and it was not difficult to select the depths to bedrock from the sound traces. The bedrock on shore was contoured by means of the records of the borings. Hence, beginning with those sound records closest to shore, the elevations of bedrock were interpolated for the entire offshore area. Subsequent test drilling confirmed that the contours as drawn were applicable to the whole area.

In the course of the Chicago work, two hidden valleys were located in the bedrock, both buried beneath an overburden of mud and silt. One is 130 feet deep and 2 miles long, more or less paralleling the shore and making an abrupt turn to the southeast to join a larger valley, once part of an

The *David C. MacNichol,* a coastal freighter, pressed into service as a research vessel. Scientists of the U. S. Geological Survey used it to test the value of Navy depth-finding equipment for deep-water investigations of mud and bedrock in areas of prospective marine and submarine engineering operations. (Courtesy U. S. Geological Survey.)

ancient southeast-trending drainage system. The other hidden valley is 6 miles to the north and is about 80 feet in depth. It was traced for 4 miles out into the lake. In addition, several other deep depressions were located along the proposed tunnel route, which means that the tunnelers will need to work at a considerable depth in order to prevent "holing out" into soft mud. The bedrock configuration, characterized by modified karst topography formed by the action of water upon limestone, bears no relation whatever to present surface features like Belmont Yacht Harbor and the lake shore. These last features resulted largely from the action of Pleistocene glaciation.

As in the previous Lake Mead work, a plan of sonic-sounding courses was laid out, and careful sextant work was required to furnish direction control for each course. The equipment used was mounted on a 60-foot tug belonging to the city of Chicago. Applying data obtained from the sonic soundings, G. G. Parker, geologist of the Survey's Ground Water Branch, completed the final map of the bedrock topography.

In the course of the Chicago survey, an experiment was performed which indicated that sonic devices may be useful in ground-water investigations. While attempting to eliminate the difficulties that occur with multiple echoes arising from sound reflections between the water surface and water bottom, the transducer was lowered and placed directly on the bottom at a number of places.

Sextant readers and horizontal control operator at work on the upper deck of the pilothouse determining position of the vessel relative to shore points. Great care had to be exercised in the Bay of Fundy studies to maintain a straight course in spite of strong tidal currents and ocean whirlpools. (Courtesy U. S. Geological Survey.)

Wrapping the transducer in heavy sponge rubber, with only the sound face exposed, eliminated some slight trouble with residual multiple echoes originating from the back of the transducer. All echoes at the receiver then must have come from the sediment.

As a result of this experiment it was concluded that, in those places where the water table is at or within a few feet of the land surface (so that only shallow holes, at most, would have to be dug for the transducer), sonic devices may be used to obtain information on water-bearing sediments below. The main requirement would be to place the transducer a foot or so below the water table when measurements are made. It is conceivable that a considerable amount of ordinary test drilling could be dispensed with wherever sediments are saturated. Greater speed should be possible also, though some drilling would be required to give necessary geologic control.

The Bay of Fundy Problem

Before an opportunity was presented to develop further this approach to ground-water studies, discussions with the Chief of Engineers of the U. S. Army brought forth the possibility that vital data on suspected unconsolidated underwater deposits at potential dam sites in the Bay of Fundy might be gained for the Government at low cost. Funds in the amount of $3,900,000 had been estimated as necessary to reexamine the project for using the wide tidal fluctuations in Cobscook and Passamaquoddy bays as a potential source of electric power.

It was considered highly probable that the use of sonic methods might determine the foundation conditions at proposed structure sites and obviate the necessity for continuing the expensive program of detailed test drilling and sample collecting and testing that had been undertaken in 1935. At the same time, such work would provide the Geological Survey added opportunity to develop the techniques for using sonic devices in sediment studies, particularly in an area where its value for uncovering unknown geologic data on the continental shelf was concerned.

It was known from sediment cores obtained in 1935 that the overburden might be of the order of 100 to 150 feet thick, and that it consisted of glacial till having a water content of 20 to 40 per cent. The till was known to be principally silt, fine sand, and clay, with some gravel as well as marine clay.

To accomplish this new mission the Survey again had to assemble equipment of greater power and considerably lower frequency than that which had been needed at either Lake Mead or Chicago. New equipment developed by the Survey and the Navy's Bureau of Ships was used. A preliminary field study of the geology was made by G. G. Parker, later relieved by Dr. J. E. Upson and S. J. Spiegel, cooperating with E. W. Perkins of the Corps of Engineers. The sounding survey was made during July and August 1951.

The Survey "fleet" consisted of the coastal freighter *David C. MacNichol* and two small power craft which were used as work boats. A separate power plant and a distribution system were installed temporarily to supply power for the electronic equipment. Structural modifications, also of a temporary nature, were made to give adequate storage and work space for the scientific personnel. A small room was constructed in the hold with a bench along one side on which the Edo sonar unit and test equipment were placed. Above the pilothouse a crude, temporary "flying bridge" was added for use by the sextant crew. Two instruments were constantly in use during the operations. One was the new low-frequency high-power unit referred to above. The other was a standard small-ship sonar unit. It had less penetration and was for use close to shore and in shoal areas, mostly as an aid to navigation.

Plots were established for 6 to 10 parallel bot-

tom profiles to be obtained by following parallel courses in each of eight areas in the vicinity of Cobscook and Passamaquoddy bays: across Letite Passage in the north, the Pope Island to Deer Island area, Western Passage, Friar Roads, Treat Island, Estes Head to Lubec, Shackford Head, and Spectacle Island. The range lines were spaced 500 to 1000 feet, and at least once in each area the ship crossed these parallel courses at right angles to give an additional check on the profiles. Altogether 44 such profiles were made, showing depth of water, depth of overburden, and depth to bedrock.

Two assistants on the flying bridge took sextant readings to shore points so that the ship's course could be accurately plotted and correlated with each depth profile. As each sextant observation was made, the angles obtained were read into the public-address system and received by the plotter in the pilothouse where the ship's position was plotted. In this way there were continuous checks on deviations from the desired range line. When these deviations were serious, a change in course was ordered. Position fixes were obtained throughout each range line and as close to the limiting shores as the vessel could approach without running aground.

Because of the large tidal variation involved (some 18 to 27 feet between high and low tide levels, constituting the differential upon which the Quoddy project would depend for its power), it was necessary to establish vertical control as well. Therefore the ship maintained radio contact with shore points where every 10 minutes the height of the tide was read and added to the record. Leadline soundings also were made periodically to check the instrumental water-depth profiles. A bathythermograph was used to record water temperatures so that it was possible to obtain the correlated temperature and depth data needed for computing the velocity of sound through sea water.

Compiling the data, interpreting them, and completing the required maps of bedrock topography took several months and called for unusual skill. Proper interpretation of the profiles amounts to converting sonic tracings into geologic data—an entirely new avenue of approach to geophysical research. Pinnacle rocks projecting above the mud stand out like radio towers on a terrestrial landscape. Their roots in bedrock areas are as apparent to the scientist as bone structure in an x-ray film.

Bedrock in the Quoddy Bay region is of the Silurian and Devonian periods. Farther inland are fossils indicating that rocks were formed in the area at least during Mississippian and Pennsylva-

Joe Upson, U. S. Geological Survey geologist, points to a bedrock outcrop of Silurian Age on shore near Eastport, the easternmost city in the United States. (Courtesy U. S. Geological Survey.)

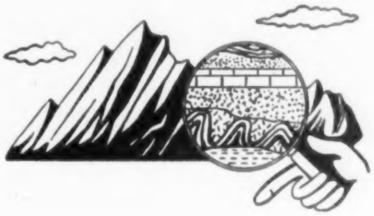
nian times also. However, glacial action and other erosional factors have removed all traces that would indicate the history of the Eastport area itself between the Devonian and the late Pleistocene.

It is the geology associated with the movements of ice during Wisconsin and post-Wisconsin times that is of most concern at Quoddy. Thick deposits of clay, sand, and gravel have been strewn about by glacial action. Sizable outwash plains cut across to the southeast. Proximity to the ocean and the tremendous weight of the intruding ice mass, forcing the coastline beneath the sea, gave the whole area a recent marine history as well. Deep canyons, some still beneath the ocean, were scoured by the action of glacial runoff. Two old river valleys extend out onto the continental shelf from present-day streams. The streams that cut them must have been much larger then than they are now. Offshore ocean currents have been at work on the loose materials available and have contributed additional deposits which show up as marine blue clay overlying the glacial till.

Some understanding of the geologic history of these surficial and submarine deposits is most necessary to engineers both before and during any construction activities. A pleasant surprise, for ex-

ample, was the discovery that the northernmost two-thirds of the coastal area where dams would be needed contains almost no clay sediment. The study showed that most of the sediments are in previously tested areas where drilling was done during 1935–36, just prior to the decision to abandon the project. The cores did serve a useful purpose, however, for they provided the needed control on which to base geophysical interpretations of the current survey. Good agreement was obtained for the bedrock elevations determined from those cores, and corresponding elevations were computed from sound velocities in the neighborhood of 6200 feet per second.

The work at Lake Mead, Chicago, and Passamaquoddy allows the conclusion that frequency is critical in so far as penetration of sediments by sound is concerned. Frequencies of 50 kilocycles and higher do not penetrate underwater sediments satisfactorily. Frequencies below 15 kilocycles do penetrate. Frequencies and power levels now obtainable appear to be adequate for locating bedrock beneath underwater sediments ranging in thickness from a feather edge to several hundred feet. The principle appears adaptable for groundwater investigations wherever the water table is close to the land surface. However, in this direction further investigation is needed.



DAY AND BEACH

On what once held an inland sea,
This shore has bits of stone.
A comber of eternity
Rolls in the wind alone.

And I, a lover of the light
And swimmer of the sun,
Now push the pale drifts left and right
That ages have begun.

DANIEL SMYTHE

Delanson, New York

SCIENCE ON THE MARCH

OUR HERITAGE OF GOOD FRUITS

PLANT breeders have given to the farmer and home gardener a number of varieties of fruits, flowers, and vegetables which are radically different from original types. In many instances dwarf varieties are available to the amateur with limited space for planting, whereas the commercial grower, who is primarily interested in larger yields, has recourse to types which produce bigger and better crops as the result of hybrid vigor. Double blossoms have largely replaced single flowers in border planting, and one may have blue roses and pink African violets if one wishes. Small fruits, like the strawberry, raspberry, and others have been bred to suit any clime in the United States so that successful production need no longer be restricted to a limited region. Another area in which the plant breeder has been successful is in the production of strains of plants which are resistant to specific diseases.

The object of this paper is not to discuss the excellent work of plant breeders, but rather to relate a few stories regarding varieties of fruits which have been given to us by nature, in many instances antedating the plant hybridizer. Sometimes the new type has arisen from a seed which was planted by a grower who knew nothing of the seed's ancestry. He merely planted a seed and "took a chance." In other instances, the new fruit has been discovered on a tree which was believed to be a seedling, perhaps found on a farm or growing "wild." The latter is sometimes referred to as a "wilding." In all cases the new variety appeared by chance, without its discoverer having had any part in pollination or hybridization or in any other manner planning its parentage.

Then there is the "bud sport." Sometimes flower buds on a single branch of a tree will bear fruits which are quite different from those which are produced on other parts of a tree. The new fruits may be seedless, they may have a different internal or external color, they may mature earlier or later, or they may be larger or smaller. These are bud sports. It is a characteristic of the whole branch which bears these fruits, because leaf-buds, rather than flower-buds, may be removed and inserted into the bark of another tree (of the same species), and the "bud wood" will grow and produce fruits identical with those of the original bud sports.

The Concord Grape. Let us begin with the story of the Concord grape. Most of us are no doubt familiar with this attractive blue variety of grape that makes its appearance on the markets in the early fall. It is the most widely grown grape on this continent and with its offspring, both pure-bred and cross-bred, represents 75 per cent or more of the grapes of eastern America. Here is how it started.

The early colonists attempted to introduce European grapes into this country from the very beginning of colonization. Grapes which they brought with them were the Vinifera or wine-grape type, such as is grown extensively in California at the present time. Attempts at wine production, or more properly the production of wine grapes, were made not only to please the palates of the colonists but also to create an industry for the colonies. So for 200 years experiments to grow wine grapes were made in all parts of the eastern United States, and for 200 years the experiments failed. It is now known that European grapes failed to grow in America because of attacks by the Phylloxera insect, mildew rot, and other native parasites to which the native American grapes are comparatively immune.

It seems that for a long time it never occurred to the early colonists to attempt to cultivate the wild native grapes. It is true that wild grapes were small-fruited for the most part and full of seeds, but the Indians utilized them. Eventually, however, the colonists began cultivating native species of grapes. John Larson, a Scotch engineer, spent eight years, beginning in 1700, in exploring and surveying North Carolina. He reported six kinds of wild grape, three of which had been moved to gardens.

Two important events occurred in 1852 which tended to revolutionize grape growing in America. The first of these was the production of hybrids between American and European grapes. The second event was the introduction of the Concord grape. It is this second event with which we are concerned. In the fall of 1852 E. W. Bull, of Concord, Massachusetts, exhibited a seedling grape at the meeting of the State Horticultural Society. The seedling was named the "Concord." Bull had planted the seed of a wild grape in his garden, and it bore fruit in 1849. The wild grape, from which the seed had come, had been transplanted to the garden from beside a field fence.

Other than this, the actual ancestry of the

Concord is not known. The botanical characters, according to Hedrick, indicate that it is a pure-bred Labrusca (Fox grape) although some are of the opinion that it is possibly a Labrusca-Vinifera hybrid. A Catawba grape vine was growing in the garden at the time that the Concord was discovered, and it is possible that the Catawba vine may have fertilized the seed from which the Concord grape was produced.

The new grape was introduced by Hovey and Company of Boston in the spring of 1854. From the time of its introduction its growth was phenomenal. Within a year its culture had spread halfway across the continent. In 1865 the Concord grape was awarded the Greeley prize by the American Institute. Horace Greeley, the donor of this prize, considered the Concord the best grape for general cultivation and called it the "grape for the millions." When one realizes that there were no other "juice" grapes at that time, it is not surprising that the Concord made such a hit. Even today this grape is one of the most popular varieties. There are better grapes in some respects, but they cannot be produced as cheaply as the Concord and must take second place from the standpoint of commercial production.

Two other table grapes appear on the market at about the same time that the Concord is offered for sale. These are the large, green or white, Niagara and the small, pink-fruited Delaware. Niagara is a known cross between Concord and Cassady, produced by C. L. Hoag and B. W. Clark of Niagara County, New York. The Delaware, however, belongs in our story because its origin is unknown. It was brought to the notice of the Ohio Pomological Society in 1851. It was traced to the garden of Paul H. Provost, a Swiss of Frenchtown, New Jersey. One story says it came from a brother residing in Italy; another that it was brought to Provost's place by a German. It could have grown up in the garden as a seedling.

Other Small Fruits. The origins of some of the other small fruits may not be as dramatic as that of the Concord grape, but many of them were chance seedlings or wildings or bud sports, and they serve to substantiate our claim that nature provided generously until man took over. For example, a very popular red raspberry, the Cuthbert, originated as a chance seedling in 1865. This is a large-fruited variety with a delectable flavor and aroma. Golden Queen is a bud sport of Cuthbert. It has been referred to as the only yellow raspberry which is worth planting. Golden Queen is more

Grapefruit on trees growing on the Yuma Mesa, Arizona (U. S. Bureau of Reclamation).

cream colored than yellow, and it retains all the flavor of the Cuthbert.

Most of the old standard varieties of black raspberries, such as the Cumberland, are supposed to have originated as seedlings. The same is true of one of the most popular purple varieties—the Royal Purple. Likewise, many of the older varieties of commercial blackberries originated by chance. Eldorado, Blowers, Agewam, Early Harvest, and Mersereau were either seedlings or wildings.

Perhaps more new varieties of strawberries than any other fruits have been introduced in recent years. In the past, however, we were dependent upon nature's productions for market varieties, many of which are still being grown commercially. A typical example is the Missionary strawberry, which originated as a chance seedling in 1916 in Virginia. It practically "grew up" with the winter strawberry industry in Florida. For about twenty-five years strawberries were shipped from Florida to the northern states during the winter months, and for many of those years it was the Missionary variety that was shipped exclusively. Strawberries were among the first luxury winter fruits in this country.

Peaches. If one seeks a dramatic origin of a variety of fruit, one need not look beyond the peach industry. The year is 1870. The scene is Marshallville, Georgia. In this region peach trees are always at their best, as they grow with their roots deep in red clay and their tops reaching up toward clear blue skies. In the year just mentioned Samuel H. Rumph, a prominent peach grower, had a "Chinese Cling" peach tree on his farm. Fruits of this variety are best suited for canning or preserving. Two seeds from the fruits of this Chinese Cling

Bing cherries from the state of Washington (U. S. Bureau of Reclamation).

tree made history. Mr. Rumph planted one seed and gave the other to his brother, L. A. Rumph. The first-mentioned seed produced the well-known Elberta peach. This is now the leading commercial variety, at least in the eastern United States. A large fruit with yellow flesh and usually red around the pit, the Elberta has graced many a fruit bowl. Since it is a late variety, it does not appear on the market until late summer, and it is marketed until frost.

What ever became of the other seed of the Chinese Cling tree? Mr. L. A. Rumph, who also lived in Marshallville, planted his seed too. Strangely this produced the "Belle of Georgia." In the opinion of many, no better peach was ever discovered. The flesh is white and not quite so firm as that of the Elberta; flavor is indescribable and Hedrick has spoken of this variety as "truly voluptuous in in form and color." Because of its tender flesh, Belle of Georgia will not stand the rigors of shipment to distant markets and is not able to compete with firmer varieties.

How did both a yellow and a white-fleshed variety originate from the same tree? Mr. Rumph stated that the Chinese Cling tree stood near Early and Late Crawford, Oldmixon free-stone and cling trees. Ample opportunity for cross-breeding existed so that each of the two seeds could have had different parents.

Other commercial varieties of peaches which originated as chance seedlings are J. H. Hale, Hale Early, Champion, Hiley, and, in all probability, Early and Late Crawford.

Cherries. Many of our leading cherry varieties in this country have a rather mysterious past. Early Richmond, a popular sour cherry, is the old Kentish of England and may have been introduced into England by the Romans. A standard late sour cherry in America is the English Morello. Its origin is unknown, but it is believed to have originated either in Holland or Germany, from whence it was introduced to England and later to France. By far the most popular sour cherry in this country is the Montmorency. It originated in the Montmorency Valley in France several centuries ago.

Of the sweet cherries, Napoleon is a leading firm-fleshed variety. It was grown by the Germans, French, Dutch, and English early in the eighteenth century, but its history prior to this is obscure. Another sweet cherry, Lambert, flourishes best in the northwestern part of the United States. This cherry originated as a seedling under a Napoleon tree about 1848.

Apples. Smock and Neubert, in their book entitled "Apples and Apple Products," state that there are well over 1800 varieties. Not many of these, however, enter into commerce today and when considering only the most popular commercial varieties in the United States, the list can be reduced to 24. And what is significant is that only one of these 24 has been produced by plant breeders. It is the Cortland, which is the outcome of a cross between Ben Davis and McIntosh. All the remaining varieties have resulted either from chance seedlings or from bud sports, or the origin is unknown. Let us consider a few of them.

Rhode Island Greening and Winesap have been traced back to Colonial days, but the exact origins of these apples are unknown. Arkansas, Baldwin, McIntosh, Northern Spy, Stayman, Wagener, and Yellow Newtown originated as seedlings during the period between 1740 and 1892. Golden Delicious is another seedling, but its advent was more recent, since it was introduced in 1916. The following varieties were "found" and in all probability they were chance seedlings: Delicious, Esopus of Spitzenberg, Grimes Golden, Jonathan, Rambo, Smokehouse, York Imperial.

Pears. Most of our popular pear varieties have come to us from Europe. Bartlett, which leads all other varieties in America in number of trees, came to us from England and is there known as Williams. A schoolmaster from Berkshire discovered this pear as a wilding and brought it to America in 1797 or 1799. Bartlett is a large, light-yellow pear and is the first to appear on our markets during the summer.

Continental origin of several other pears is evident from either their present or original names. Anjou (originally Beurre d'Anjou) is an old French

pear with origin unknown. It is an excellent fall variety with a slightly astringent "tang." Comice (Doyenne du Comice) originated as a seedling. Beurre Bosc (now called Bosc) and Winter Nellis were both raised from seed in Belgium.

Our first typically American pear was the Seckel. Most of us remember this small, sweet, red-cheeked pear from our school days. Six or eight of these small fruits could be carried in our pockets at one time. The story of the origin of the Seckel pear is as unique as that of any other thus far unfolded. Toward the end of the eighteenth century there lived in Philadelphia a well-known sportsman and cattle dealer. He was known by the name of "Dutch Jacob." Each autumn Dutch Jacob would bring exceedingly delicious pears back from his hunting trips and would would distribute them to his neighbors. The exact location of the pear tree was known only to the huntsman. Soon a tract of land south of Philadelphia was sold in parcels and Dutch Jacob was one of the purchasers. As a result of his purchase he became the owner of the land where his favorite pear was growing. This was near the Delaware River. The land subsequently became the property of a Mr. Seckel, who gave the pear its present name. What about the origin of the pear? Your guess is as good as mine.

The Washington Navel Orange. In 1896 the Reverend F. J. C. Schneider, the first Presbyterian missionary to Bahia, Brazil, wrote to the U. S. Commissioner of Agriculture, telling him about an orange, grown locally, which might have commercial possibilities in the United States. This was the Navel orange. It probably originated as a bud sport. At any rate the orange appears to have been propagated between 1810 and 1820 by a Portuguese who lived at Cabulla, a suburb of Bahia, Brazil. It was here that the Reverend Schneider first saw the Navel orange.

After an unsuccessful attempt to ship bud-wood to the United States, a shipment of twelve budded trees was forwarded to the U. S. Department of Agriculture in Washington, D. C. They arrived in good condition in 1870. Other trees were propagated from these, and two of them were sent to Mrs. Luther C. Tibbetts, in Riverside, California. Mrs. Tibbetts grew the trees in her backyard. It is from these two trees that the Navel orange in-

Irrigation of a grape vineyard south of Fresno, California, from the Friant-Kern Canal.

dustry of California, and mainly of the whole world, has developed.

This Navel orange has had a number of "first" names. After its introduction into the United States it was called the "Bahia Navel." Later it acquired the name of the "Washington Navel," because of its having been propagated first in Washington, D. C. Next it was the "Riverside." Now it is once more called by horticulturists the Washington Navel, although tradespeople usually refer to it as the California Navel orange. This is not surprising since California supplies most of the navel oranges which we see in our markets. Florida-grown Navel oranges are quite popular with the frozen- or cold-section trade. Fruit sections are peeled for salads and shipped in gallon containers to the larger markets.

Seedless Grapefruit. It is strange how we show a preference for seedless varieties of fruits. The fruit merchant, realizing this, usually advertises his "seedless grapefruit" with large placards; but if he is selling the Duncan "seedy" type, he is more than likely to avoid any reference to internal quality. The housewife, too, prefers to serve seedless grapefruit. What if the seedy types of grapefruit do possess better quality—more sugar, more vitamins, and more minerals—than the seedless type? It seems that most of us still do not like to cut out seeds before serving and therefore, because of its seedlessness, the Marsh grapefruit eclipses all other varieties.

In 1862 William Hancock, of Socrum, near Lakeland, Florida, purchased a farm from one Mrs. Rushing, who is credited with having set out three seedling grapefruit trees. One of these trees bore seedless fruits and thus became the parent of the Marsh Seedless. Bud-wood was purchased by E. H. Tison, a nurseryman, who subsequently sold his nursery to C. M. Marsh, another nurseryman. The latter then marketed it as the Marsh seedless grapefruit. It is believed by some that the Marsh grapefruit originated from a "root-sprout" of an old tree which normally produced seedy fruits. Others still adhere to the theory that this variety originated as a seedling. Whatever the case, the Marsh grapefruit is now grown extensively in Florida, Texas, California, Arizona, South Africa, Israel, Australia, and South America.

Pink Grapefruit. At Manavista, on the Gulf Coast of Florida, may be found the Atwood Groves. If nothing unusual had ever happened to these groves they would still be famous because of the fact that the rows of grapefruit trees are a mile long. But something more important did happen in this grove.

In the citrus season of 1906–07 R. B. Foster was foreman of the Atwood Grove. Mr. Foster was sampling grapefruit and, when he cut open a certain one, he found to his surprise that it was pink. Other fruits on this one branch of the tree were also pink. *One branch on one tree in a grove of thousands of grapefruit trees bore pink grapefruit.* It is not surprising that Mr. Foster marked this particular branch with a large "P" (to indicate pink) in order that he might not miss it when returning. It should be mentioned that the original tree on which the pink-fleshed fruit was discovered was the Walters variety, a pale-fleshed, seedy fruit. This newly discovered pink grapefruit was therefore seedy too.

In 1913, in the Thompson Groves at Oneco, Florida (not too far from the Atwood Groves), a bud sport was found in a Marsh seedless tree. The fruit in this case was pink and seedless. Thus originated the Thompson Seedless grapefruit. This variety is pink fleshed and seedless.

The trees of Thompson (or Pink Marsh) grapefruit were sold to Albert E. Henninger of McAllen, Texas, in1926. In 1929 a new red-fleshed variety originated as a bud sport on one of these Thompson trees in Texas. Henninger called this new sport the "Ruby" and obtained a patent on the fruit. This was the first citrus fruit to be patented. The Ruby grapefruit is grown extensively in Texas, and it is mistakenly believed by many that all pink-fleshed grapefruit originated in that state.

The Temple Orange. No connoisseur of citrus fruits speaks of quality in oranges without mentioning the Temple variety. More and more this particular orange is becoming a familiar sight on the markets—deep orange in color, oblate to spherical, the peel slightly pebbled. To the layman it is often a "kid-glove" orange, for there is much in it that resembles the tangerine. The aroma and flavor of the orange-colored flesh can be described only as superlatively delicious—for want of a more descriptive term.

According to Webber and Batchelor the original Temple orange now stands in the old homestead of William Chase Temple in Winter Park, Florida. But according to T. Ralph Robinson, this tree in Winter Park was budded from the *true* original tree which is in Oviedo, about twenty miles away. The bud-wood for the tree in Oviedo was imported from Jamaica. And this is as far as we can go in depicting the origin of the Temple.

The characteristics of the Temple orange certainly suggest that it is a hybrid because it is part like a Mandarin, such as the Tangerine, and part like the common sweet orange. However, since it

is susceptible to scab (and the sweet orange is not), it may have resulted from a cross between the Tangerine and the sour or Seville orange. But no Tangerine ever had enough sugar to overcome the acid normally found in a sour orange, so what tended to sweeten this offspring of the sweet and sour fruits one will never know.

It may be interesting to the readers to learn that there is a limb on the original Temple tree which regularly produces "navel" fruits, that is, Navel Temples. This may account for the fact that many of the Temple oranges in commerce show a protruding Navel, much like California Navel oranges.

Many other common varieties of citrus fruits appear to have originated by chance. Among the oranges, Boone's Early, Parson Brown, Conner's Seedless, and Pineapple originated as seedlings, and Hamlin and Enterprise are believed to belong in this category. The most popular Tangerine, the Dancy, began as a seedling. The same is true of the Eureka lemon, which is the most extensively grown variety of lemon in California.

It will be observed that a number of the varieties of fruits which we have listed are still in use. This is particularly true of the tree fruits (apples, peaches, pears, and citrus). One reason for this is that a much longer period is required to bring a fruit tree into bearing than is required for small fruits and vegetables. A plant breeder may spend years merely culling out undesirable crosses in his program. The hybridization of citrus fruits is fraught with still another difficulty. The seed of an orange or grapefruit may produce more than one seedling. Both the ovule and the nucellus may give rise to a new plant upon germination. The shoot springing from the fertilized ovule is a true hybrid, but that which originates in the nucellus is merely a vegetative sprout possessing only the characteristics of the female parent.

It is not the purpose of this paper to belittle the excellent work of plant breeders in this country who have introduced so many new and desirable types of plants. Our object has been to show how nature's guiding hand supplied us with many of our fruits until plant scientists were able to take over. Research workers in state and federal agricultural experiment stations and private institutions are performing an excellent service and many new types of fruit are now in commercial production. According to Darrow, 312 varieties of small fruits were introduced in this country between 1920 and 1950 and 98 of these are of some importance. By 1950 new varieties which were originated by government agencies alone accounted for about 55

Doubling the chromosome number is one way to increase the size of fruit. On the right is an ordinary diploid Winesap apple. On the left is a giant apple chimera composed mostly of tetraploid tissue inside and diploid tissue on the outside; it was produced by Dr. Haig Dermen of the U.S.D.A. Plant Industry Station at Beltsville, Maryland. From it a completely tetraploid plant, usable in apple breeding, may be produced. (U. S. Bureau of Plant Industry.)

per cent of the entire strawberry crop, 95 per cent of the red raspberries, 50 per cent of the purple raspberries, 30 per cent of the black raspberries, 5 per cent of the blackberries, 95 per cent of the blueberries, and 2 per cent of the grape crop. Some of the new varieties of peaches are now well established in trade channels and are rapidly becoming favorites among consumers. Other examples might be cited here if space permitted.

It should be borne in mind that our present mode of life has placed much greater demands upon the plant breeder than existed fifty years ago. Fruits of good desert quality and attractive appearance may be satisfactory for home consumption, but they may not tolerate shipment to distant markets or they may not be suitable for canning, dehydrating, or freezing. In fact it is now realized that no one variety can be expected to meet all these requirements and that we must look for a type for each specific purpose.

It is surprising therefore, that so many of the older varieties of fruits have stood the test of time so well. They represent a challenge to modern plant breeders and offer mute evidence of nature's handiwork.

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References

BAILEY, L. H. *The Standard Cyclopedia of Horticulture.* New York: Macmillan (1935).

BEACH, S. A. Apples of New York. 2 Vol. N. Y. Agr. Expt. Sta. Rept. (1903).

DARROW, G. M. Breeding of Small Fruits in the United States. *Sci. Monthly,* **75,** (5), 288 (1952).

HEDRICK, U. P. *Cyclopedia of Hardy Fruits.* New York: Macmillan (1922).
HEDRICK, U. P. The Grapes of New York. N. Y. State Dept. of Agr. 15th Ann. Rept. (1908).
HEDRICK, U. P. The Cherries of New York. Dept. of N. Y. Agr. Expt. Sta. Rept. (1914).
HEDRICK, U. P. The Pears of New York. N. Y. State Dept. of Agr. Ann. Rept. (1921).
HEDRICK, U. P. The Small Fruits of New York. N. Y. State Agr. Expt. Rept. for 1925.
ROBINSON, T. R. The Bud-Sport Origin of a New Pink-Fleshed Grapefruit in Florida. *J. Heredity,* 12, (5), 195 (1921).
ROBINSON, T. R. The Origin of the Temple Orange. Proceedings of the Florida State Horticultural Society, 1945. pp. 3–5. (1946).
SMOCK, R. M., and NEUBERT, A. M. *Apples and Apple Products.* New York: Interscience (1950).
WEBBER, H. J., and BATCHELOR, L. D. The Citrus Industry. Vol. 1. History, Botany and Breeding. Berkeley and Los Angeles, Calif.: University of California Press (1943).

THE IMPACT OF CHEMISTRY ON THE WORLD OF SCIENCE*

MANY things may be learned from the meetings of scientific organizations where men bring the fruits of their labors and hold them up for all to see. From these meetings one thought recurs: research has come a long way in a relatively few years. Yet the active researcher who knows what riddles are still unsolved, who sees how much more needs to be done, and who senses that what will be done will dwarf what has been accomplished is impatient with anyone who pauses to look back. Although the accomplishments are impressive, the eager researchers are right—there is still a long way to go.

An association like the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE numbers among its membership men of all sciences. A good proportion are university men and staff members of research foundations. Others are the applied scientists, the individual and specialized vertebrae of the scientific backbone of industry. They first concern themselves with problems of pure science. They are the miners, the diggers who unearth nuggets of bright new truths from the mountain of phenomena that surrounds our existence. They are the searchers for the needle of causality in the haystacks of empirical knowledge. They are the architects of theories and the clever builders of natural laws. The scientists of industry, the applied scientists, use their time and their wit putting science to work. They are the goldsmiths who fashion the nuggets of pure science into useful or beautiful artifacts—the processes, the services, and the products—that insulate and move mankind away from the state of uncivilized nature—in which Hegel said life was nasty, brutish, and short.

* Based on an address given before Section C, at the Annual Meeting of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, St. Louis, Missouri, December 29, 1952.

It would seem that an association such as the AAAS might be a living nucleus for germinating a plan of integration among all sciences represented in the association. Out of such an integration, we might indeed see a most impressive and productive alliance cooperating to what certainly is a worthy end—a coordinated assault on the problems that attend putting science to work for mankind.

In the last twenty-five years the need for scientists in industry has mushroomed at a fantastic rate. This was inevitable for several reasons. Industry has expanded; the products of industry have become more complex; and, under the system of competition that prevails, management has seen the value of research and how well the logic of the scientific method and the data of the laboratory can serve the problems of manufacturing. Coupled with the interruption of training because of World War II and the indiscriminate attrition of scientific people by the needs of a garrison state, we are suffering an acute shortage of scientifically trained people. This shortage threatens to become disturbingly acute before it has any tangible hope of relief.

From time to time over the past few years, I have wondered whether members of the fraternity of pure scientists might not feel a touch of resentment because industrial employment makes such inroads upon the limited supply of scientific manpower. Each feels his own task and his own dedication to be supremely important. The depth of devotion of these earnest researchers for fundamental knowledge can be measured by their tireless persistency, by the years they spend accumulating their data, testing and retesting their facts, and refining their theories. This singleness of purpose marks the true research mind. The goals of the researchers so fill their lives that virtually every

other activity shrinks in proportion. Can anyone blame them if they have only shallow curiosity about unanswered questions outside their immediate inquiry and short patience with problems unrelated to their specialty? Hubble, the eminent astronomer, expressed this perfectly when he found to his chagrin that he was unable to answer a question about a planet in our solar system. He said, "I have commuted to the spiral nebulae so long that I have forgotten the suburban stations."

Yet applied industrial research need make no apology for its contribution to the growth of scientific knowledge. The sole difference, in fact, between the two fields of endeavor is the aim of the research worker. Both fields use identical methods of inquiry. As Weidlein and Hamor have remarked, "An investigator in pure science purposes only to advance knowledge, whereas an investigator in applied science desires primarily to contribute to industrial progress." The growing body of scientific knowledge that is swelling our libraries and trade journals is gaining nourishment from both the work of pure scientists and industrial scientists. Industrial research programs have expanded so much it may be said that the healthy, twentieth-century body of science is the result of a vigorous symbiosis between pure and applied research.

There is no question that within the various scientific disciplines fundamental knowledge derived from pure research is the parent of the accomplishments of the applied scientists. The evolution of each of the sciences follows a similar pattern as it develops. First, definition of the field and its limits; next, codification of data; then, the refinement of measurement; and finally, application of findings. In astronomy it can be traced as the emergence of the science of astronomy from the melange of astrology, the development of more precise measurement, on to its application to navigation, to accurate time measurement, and ultimately perhaps to prediction of weather changes and climatic cycles.

In chemistry, the pattern is much the same. Its earliest beginnings were rooted in what today we wonder at as the weird art of alchemy. Chemistry, in its primitive beginnings, was the empirical manipulation of completely misunderstood materials of nature. Then fundamental research discovered the basic elements, and codification proceeded. Fundamental research discovered the law of combining weights, Boyle's law and Charles' law. With this basic information, chemistry began its growth. Vast development of applied chemistry, however, could not begin until it teamed with engineering—so that its products could be made for mass use and made dependably uniform. When this level was reached, the science of applied chemistry was in position to take the findings of pure science and translate the knowledge into products or processes for use and to refine these end products for maximum effectiveness and to broaden their application to the widest possible usefulness.

Would any pure scientists contradict the statement that applied chemistry has tremendously benefited, not only the human race, but even the other sciences as well?

The science of chemistry started out as the groping, empirical manipulation of almost completely misunderstood materials found in nature. It proceeded to the refinement and duplication of materials found in nature. Over the past few decades, it has started the creation of a variety of improvements on nature, and herein lies the most profound promise, the most dignified and humanitarian significance of applied chemistry.

The contribution of chemistry to the advancement of science may be likened to a path through a labyrinth which has corridors that wind through all the specialties and through all the industrial arts. Science is knowledge; therefore, each chemical product, process, or application technique that adds to man's total body of knowledge is a step forward. Chemistry's contribution to other sciences is also a vast region. To paraphrase John Donne: No science is an island unto itself but all are part of the main. None of the physical sciences can disclaim its debt to mathematics, nor to one another. Advances in physics, chemistry, biology, and medicine codevelop, move forward on stepping stones which frequently are created by the findings of another science.

It is most astonishing to trace the interweaving of chemicals and chemical techniques among particular branches of science and throughout the industrial arts. Industrial chemists were called upon during World War II to help operate the chemical phase of the atomic energy project at Oak Ridge, Tennessee. Certainly, the engineering and operation of the first plant to manufacture fissionable materials was in itself a significant contribution to science by industrial chemists; but, the peculiar nature of the chemical products that have been developed gives us a radioactive tracer to determine how this particular piece of chemical engineering has contributed to the advance in other scientific fields. These contributions have been wholly peaceful and beneficial.

The radioisotopes that are produced as by-products of nuclear fission are chemical products. They are materials not present in nature. They are not pushed into service with the same aggressiveness and sales promotion that assist the distribution and expand the use of other chemical products. Despite this, merely the quantitative production and the known availability of the radioisotopes have started a bewildering variety of research projects that some day will have very practical and beneficial applications.

The studies are amazingly diversified. One project is studying the sterilization of food in closed containers by subjecting the packaged foods to radiation that penetrates tinplate, glass, and paper. Hermetically packaged foods, some day in the future, may be radiated instead of heated, refrigerated, or chemically preserved.

Biologists are using radiocarbon in the study of photosynthesis. Radiomanganese, radioboron, and radiocobalt have been impressed into the scientific study of the molecular structure of steel alloys, thus giving metallurgists accurate pictures of the crystal structure of metals.

Radioactive compounds are making significant headway in medicine. Among these is radioiodine used in the treatment of the thyroid gland and in cancer research. Perhaps the latter application holds the most dramatic interest. The most encouraging results to date have come from the work on blood cancers, where differential absorption of radiophosphorus is localizing treatment, and in cancer diagnosis, where radiation signals the presence of hidden tumors.

Still other uses of radioisotopes have developed in the field of antistatic agents, in gages for controlling the thickness of paper, sheet metal, and rubber. At Mound Laboratory, Miamisburg, Ohio, research is being carried out on radioactive wastes, safety measures, and other topics assigned by the AEC. The chemical researchers there have developed a microtorsion balance so sensitive that it will weigh quantities as small as one microgram, approximately one twenty-eight millionth of an ounce. Here is a most significant instrument, developed in applied chemical research, that can serve in a number of other sciences. The design of the Mound instrument is based on a balance, developed in the Metallurgy Laboratory at the University of Chicago, that operated on the torsion of quartz fibers. In the laboratory at Mound, the chemists made major improvements in the methods of drawing uniform quartz fibers and fusing them into delicate beam assemblies. The balancing of the load is measured on the twist of a quartz fiber which can indicate one twenty-thousandth of a revolution of arc. The instrument has been built and is in operation. Now it is available for any kind of microchemical or microbiological research.

Radioisotopes are unique in the history of chemistry as examples of useful materials that are serving many of the sciences. They are without question the most spectacular of the materials on which chemistry has presumed to make an improvement on nature. But there are others. In the field of plastics and resins, a whole new department of creative chemistry is unfolding. Polymerization and condensation reactions have already produced three dozen commercially important polymers, copolymers, and resins. These materials run the gamut of properties which were formerly possessed only by diverse materials found in nature. They offer transparency, lightness, insulating properties, controlled flexural strength, and impact strength. They can be hard, they can be flexible, they can be elastomeric. Plastics have put at man's disposal new methods of manufacture: molding, extruding, and laminating. As little as fifteen years ago, plastics materials were unimportant in the lives of average people. Today they touch many of the sciences and contribute to work-a-day living almost every hour of the day.

Consider the growing wonder-boy of science, electronics. Here, too, plastics have made a contribution that is small but unique. The new and tiny transistors and the fixed circuits which are embedded in plastic are an example. Electrical engineers know that the little bead that holds the wire terminals to the crystal of germanium and the plastic that permanently embeds a whole amplifying circuit, for example, must be very special materials. These plastics were developed by industrial chemists, and they were ready for use when electronic scientists wanted them.

The next few years will see a phenomenal development of chemically made materials. One of these will be the ployester-glass fiber laminates which can be formed by low-pressure lamination into a variety of large products and large product sections. Even now these materials are making radar domes, automobile bodies, storage tanks, noncorrosive pipe, electrical panels, and even sail and motor boats. They are translucent, weatherproof, nonconductive, and chemically resistant. With special resins, they can withstand heat up to 500° F. They have tremendous impact and flexural strength, and are ready for use by the electronics industry, for signal equipment, circuit panels, and

housings. There is a long list of other applications where metal, wood, glass, or ordinary plastics will not serve. They will also serve agriculture, construction, and chemical engineering. These low-pressure laminates will soon be recognized in many fields as a real contribution to the materials available to scientists and inventors.

Closely akin to plastics is the development of synthetic fibers. This phase of industrial chemistry is hard to keep in sober perspective. From Chardonnet silk to nylon; from Italian staple made of casein to Orlon, Acrilan, and their brethren—the industrial chemist went from a transformation of natural cellulose and protein materials to a complete divorce from nature even as a supplier of raw materials! Just as nylon has superseded silk in most of its qualities as well as in price, so too will the wool-like staples of today be thoroughly acceptable improvements for the best that nature can supply.

While synthetic, wool-type fibers are making a place for themselves today in blends with natural wool and other fibers, their significance is far greater than the addition of another product to commerce. We are now operating purely on cost, under rules of a science we call economics. In time, the discipline we call economy will have to give way to ecology. Then, need will demand that we make the most efficient use of our resources—cost then will not be of major importance. When that time comes, the applied chemist's ability to make suprasilk, suprawool, and perhaps supracotton fiber will be given its just due.

In the years ahead, chemistry must contribute enormously and effectively to the science of food production. The present losses inflicted on growing crops by insects and weeds is appalling. It has been estimated that insects alone destroy as high as four billion dollars worth of crops annually. Plant fungi and other plant diseases destroy a like amount. Weeds, which rob the soil of nutrients, choke crops, clog irrigation ditches, and poison farm animals, cost farmers five billion dollars yearly. If these estimates are somewhere near right, there is a thirteen-billion-dollar loss in food and fiber products annually, an amount equal to 42 per cent of the 1950 value of crops grown. There is proof that this loss is preventable, but the problem goes beyond preventing losses, important as they are.

If population in the nation continues to increase at its present rate—an increase of more than two million a year—by 1975 there will be at least 25 per cent more people to feed and clothe, that is, there will then be five for every four now living. This extra 25 per cent must be fed three times a day with food that must be raised on the farms. It can be estimated roughly that it will take 15 billion more eggs a year, 20 million more hogs, and another 10 billion quarts of milk—about 30 million extra quarts a day—to keep the nation eating as well as it does today. To help them meet the demand the farmers are going to look to the science of chemistry.

That research will be effective, there is little doubt; but how efficient will it be, considering the lack of so much fundamental data? The successes chemists have had to date have been largely the result of persistent, empirical groping. The try-and-see techniques, however, have brought to light some rather wonderful products. In the field of insecticides, chemicals range from DDT through organic phosphates. There are roughly twenty-five commercially important insecticides, all largely unrelated chemically. They kill insects, certain ones, but there is need for more data on why and how.

As far as the chemist is concerned, perhaps the most intriguing developments among the chemical bug weapons are the systemic pesticides that the industry is studying carefully. These insecticides are compounds that plants can absorb through the foliage or roots and that make the plant itself toxic to insects. In effect, these compounds make the whole plant an insect killer. Perhaps this promises help with the problem that is beginning to plague—bugs are apparently developing immunity to some of the known insecticides. Witness the housefly's growing contempt for DDT. If the promise is fulfilled, why could not plants be made immune to blights, rusts, and other fungus attack as well? To make this possible, a vast amount of fundamental knowledge about the life processes of plants is needed. Meanwhile, systemic insecticides and the methods of using them are the subject of research and are being developed empirically.

Chemical soil conditioners are another achievement of applied research. They will contribute enormously to the science of agriculture. From the standpoint of specific research, here are some possibilities that are opened up by this discovery. With synthetically made soil conditioners, biologists can study more carefully the relationship of organic and inorganic fertilizing materials as each contributes to plant growth. Since the soil conditioner adds no food materials to soil and yet creates the loose, porous structure once obtainable only with the polysaccharides and polyuronides derived from decaying organic matter, it is now possible to measure the relative efficiency of plant foods obtained from manures

and plant residues, and plant foods obtained from mineral fertilizers. Synthetic soil conditioners open another avenue of research that can lead to more knowledge about the function of particular kinds of soil organisms. By supplying researchers with a soil conditioning agent that is absolutely sterile and inert to microorganisms, biologists can now more easily study the relationship between soil bacteria activity and its relation to plant growth and mineral nutrients in well-aerated soil.

In weed control, too, significant progress is made slowly year after year. Not too many years ago farmers had to rely on manual cultivation or oils, rock salt, or chlorates to burn above-ground growth. Today the hormone type herbicides which kill the entire plant, including the roots, are well along in their development. The commonest of these, of course, is 2,4-D. These translocated type herbicides have been of inestimable value in controlling perennial weeds and in destroying prolific annuals before they reach the seed stage.

Since there is not too much fundamental knowledge of why the hormone type weed killers work as they do, chemical weed control develops roughly along the following lines. A herbicidal compound is discovered; it is rough screened to determine on what types of weeds it is most effective and what types of crops will tolerate it. Economical and easy-to-use formulations are developed from its chemical characteristics. These are widely field tested at varying rates on a variety of weeds, and by this time a list of weeds resistant to its effects has started to grow. The compound is tried in combination with other herbicidal materials. Research then comes up, empirically, with an altogether different type of compound that shows promise of being effective on weeds that the first type does not control. The whole process is then repeated.

This pattern has been painstakingly enacted in industrial research for the past six years. At the outset 2,4-D proved to be extremely effective on broad-leaved weeds, but its effect on woody plants was not satisfactory from an economics viewpoint. Industry soon developed volume production of 2,4,5-T, another empirical hormone type herbicide that is highly successful on woody plants. It was shown conclusively in 1951 that this compound used with 2,4-D could conceivably eradicate the mesquite which has been progressively invading the grazing lands of the west and southwest since the turn of the century.

In time, the chemical industry may be able to supply a whole arsenal of herbicidal chemicals and techniques for using them that will destroy all the common species of weeds. This arsenal could be developed more quickly and more effectively if more is known about the life processes of plants.

Plant fungi are another chapter in the story. Fungus diseases ruin an estimated four billion dollars worth of fruit, grains, and fiber each year. A little headway is being made, but not much. Apple scab can be controlled and so can cherry leaf spot. Plant fungicides have increased the output of Anjou pears by an estimated three hundred million boxes a year. However, the surface has hardly been scratched in controlling the bewildering variety of rusts, blights, smuts, and rots that attack roots, stems, leaves, and fruit. There is a gleam of light in the darkness—the use of antibiotics in agriculture. It was reported recently that aureomycin, terramycin, and streptomycin proved toxic to the microorganisms responsible for halo blight on beans.

The empirical approach of applied science is dangerously slow, considering the seriousness of the problem. The potato famine of Ireland in 1845 and 1846 reduced the population of that potato-economy-society from 9 million to 6.5 million in 6 years. What was the fungus and how can it be fought? It took 100 years to make any progress, and even today knowledge regarding it is limited. In 1950 Chile had its entire potato crop wiped out by the same disease.

The problem that faces both pure scientists and applied scientists reduces to the question of how to secure greater productivity from every available acre with the least amount of human labor, and then, how can the products be best protected fully until they are ultimately consumed?

This problem could be paraphrased to cover stock raising. Concomitant with upgrading herds and flocks by improving strains, there is an increase in productivity through scientifically fortified feeds. Today, the chemical industry is supplying pure phosphate mineral supplements, antibiotics, choline chloride, amino acids, and vitamin B_{12} to the makers of stock feeds. It soon may be supplying special wetting agents that preliminary studies have shown may increase feed efficiency.

The following figures will show what these chemical products contribute. In production of broilers in 1941 it required twelve weeks to produce a bird weighing 3.83 pounds. To do this it took 3.50 pounds of feed per pound of meat. Today, with fortified feeds, a bird of substantially the same weight can be produced in ten weeks and requires only 2.87 pounds of feed per pound of meat. Rounded off, fortified feeds make it possible to

produce a three-pound fryer in nine weeks with 9 pounds of feed, whereas it formerly required twelve to fourteen weeks and 12 pounds of feed. Similar remarkable results can be cited for cattle feeding, for milk production from dairy herds, and pig feeding. For example, it used to take an average of three hundred days to produce 100 pounds of pork, live weight on the hoof, and required 12 bushels of corn. Today, with fortified feeds, 100 pounds of live weight pork can be produced with 5½ bushels of corn and 45 pounds of feed supplements in approximately sixty days.

The longer one is in the business of making chemicals, the more one is amazed by the breadth and variety of their application in the numerous practical sciences we call American industry. There are over 500,000 organic compounds known today and in a few more years this figure will be close to a million. Industrial research teams constantly prepare new chemical compounds, usually working with compounds that are intermediates in the established lines of products. As a result, a steady flow of completely new chemicals stream out of industrial laboratories. Many times there is not the faintest idea as to what they can do. They may be valuable medicinals, plasticizers, corrosion inhibitors, herbicides, insecticides, emulsifiers, or may have any one of the uses in the whole gamut of applied chemistry.

The advertisement that heralded the early mass production of silicones epitomizes the problem of a new compound. The advertisement said in effect, "What can you do with bouncing putty?" Many uses have developed for this compound. One of the major uses is not too much of a direct contribution to science—but bouncing putty it seems is an excellent center core for golf balls.

In the past year laboratories have synthesized a large number of new compounds. About one-third of these appear to have promise for further work, but of this one-third only one out of seven ever emerges as having commercial possibilities. These new chemicals are screened for familiar uses, but the aid of researchers in other industries is also enlisted. Samples are sent to the pharmaceutical industry, the dye industry, the paper industry, and to other chemical manufacturers for evaluation in their particular fields. Frequently these new compounds find a use in other chemical manufacturing as a stepping stone—what is called an intermediate—to production of another chemical product. Sometimes a demand for the chemical compounds grows without knowledge of the use to which the purchasers put them. From time to time while one group is working largely in the dark to find a use for a compound it is in a good position to make, some others develop an unusual and profitable use that was completely overlooked by the first group.

The industrial research man is faced with so many unknowns that block his progress that he may at times question the free and untrammeled pure researcher in some of his choice of projects. Perhaps this is a perennial dilemma. While the value of academic freedom is recognized, many problems of a basic nature that are simply crying for answers must be faced. The answers can only come from researchers in pure science.

If the magnitude of the job ahead is taken into account, it may be wise for the university men who lead graduates into thesis work and the research administrators in pure science to ask two questions:

"Is this project truly a work that has significance, or is it simply a challenge to the ingenuity of my specialty? How does this inquiry rate in the value of its findings when measured against the pressing need for basic information in the field of applied science?"

Scientific progress will accelerate primarily because each new advance establishes another point of departure for what is to follow. The chemical industry makes its greatest contribution in providing new tools for scientists in medicine, public health, agriculture, and other callings. These chemical tools may have tremendously broad applications across a variety of sciences—such as those described in discussing the radiosotopes. Or they may make a relatively selective contribution as in the case of the plastic used in transistors and fixed circuits. Nevertheless, in the exciting era that is opening, chemistry will have a prime role in the developments that will service the improvement of twentieth century food, clothing, and housing.

The chemical industry will even have a place in the sciences that are extending man's senses, carrying his voice around the world, extending his sight and hearing beyond the horizon, and increasing his calculating abilities beyond Euclid's wildest imaginings.

With radar, servomechanisms, and electronic brains, no one will deny that we are coming within reach of many of our wildest dreams. Certainly no one will deny that the chemical industry will produce the materials out of which these dreams will be made!

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BOOK REVIEWS

SCIENTIFIC VOCABULARY

An Explaining and Pronouncing Dictionary of Scientific and Technical Words. W. E. Flood and Michael West. London, New York: Longmans, Green, 1952. viii + 397 pp. Illus. $2.25.

ONE of the difficulties that haunts makers of dictionaries is that of defining a word in language which can be understood by persons who need the definition but have only a limited vocabulary. The difficulty is increased if the word is in a technical area in which both vocabulary and experience are lacking. For this reason a serious attempt by qualified scholars to explain scientific and technical terms to laymen in a particular field deserves notice and commendation.

Such is the *Explaining and Pronouncing Dictionary of Scientific and Technical Words* prepared by Flood and West. The work includes "10,000 scientific and technical words in 50 subjects explained as to a person who has little or no knowledge of the particular subject." Explanations are often accompanied by pictures and diagrams, a total of 1300, we are told. Though explanations are designed to be "of such length as is necessary to give an idea of the meaning," the book is not an encyclopedia. The explaining vocabulary is limited to about 2000 words, 56 of these are "definitely technical" (such as, ampere, electron, hydrocarbon, protein, and spectrum). "About 120 others might be unknown to a child or English-speaking foreigner."

The following explanation of "absolute zero" in contrast with the definition in an unabridged dictionary will illustrate what the authors have tried to do.

Flood and West: "0° C. on a centigrade thermometer is the temperature at which water freezes; but ice has some heat; e.g. ice is hotter that liquid air. At absolute zero there is no movement of the molecules and so no heat at all; − 273.13° centigrade." (There is a cross-reference to K degrees.)

An unabridged dictionary: "*Physics,* the beginning, or zero point, in the scale of absolute temperature. It is equivalent to − 273.1° centigrade or − 459.6° Fahrenheit, and is the temperature, never attained, corresponding to entire absence of heat."

The definition of Flood and West illustrates the help which may be given by a simple background explanation, viz., even frozen objects have some heat, and also the difficulty of knowing what to include in the explanation. The phrase "no movement of the molecules and so no heat at all" probably suggests a need of more information than can be assumed for the nontechnical reader.

It would be easy to find fault and even to poke fun at some of the explanations. For example, yeast is said to be a "living fungus-like substance used to make the holes in bread. . . ." (The definition continues but without further reference to bread.) To poke fun, however, would suggest that the reviewer has little insight into or appreciation of the difficulty of the authors' task. It is more appropriate to praise the work as a significant effort to explain technical terms to a nontechnical audience. The book should be helpful to students who have limited scientific training or, as in the case of foreign students, who have a limited English vocabulary. It should be an inspiration to those who by profession must teach the meanings of words. One of the authors, Michael West, has had an especially long and distinguished record in helping people to understand language and to use it effectively.

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GAMES

Introduction to the Theory of Games. (The Rand Series). J. C. C. McKinsey. New York: McGraw-Hill, 1952. x + 371 pp. Illus. $6.50.

PROFESSOR MCKINSEY has written the first systematic textbook on the Theory of Games since Von Neumann and Morgenstern brought out their original work on the subject. Starting with rectangular games for two players where each has a unique optimum strategy, the general theory of such games is developed, reference being made to graphical and approximate methods. More general two-person games are next considered, and their graphical representation and the concept of information sets are introduced. The consideration is first confined to the case where a finite number of strategies is available and then to the case of infinitely many strategies. Two chapters of necessary specialized mathematics—Distribution Functions and Stieltjes Integrals—follow, the latter being based on Widder's treatment. The way has now been paved for the introduction of continuous two-person games and the notions of "separability" and "convexity" of the "payoff" function. Applications of the theory to Statistical Inference and Linear Programming are next illustrated. The final chapters of the book consider the theory of n-person games, first with the zero sum restriction and finally without it. The book ends with a short chapter describing several important unsolved problems in the theory of games.

Although it is claimed that only a knowledge of advanced calculus and classical algebra is presupposed, it is doubtful whether anyone unfamiliar with certain other branches of mathematics would find this an easy book to read. Certain of the arguments used are of a type best understood by readers with the experience of manipulating inequalities in lattice theory or measure theory. A short summary of matrix properties, which is included, seems to fall between two stools. It is unnecessary for any reader with a basic knowledge of

them, and is too condensed and not in the best logical order of development for anyone unfamiliar with them. The notation used is unnecessarily clumsy in places, e.g., J_3^T to denote the column vector of three elements each unity, and it is not surprising to find a misprint in the midst of it (p. 69, line 4).

Because of the difficulty of certain sections, it is not quite clear for whom this book is best suited. A mathematics graduate wishing to do advanced work in this field would find it an excellent guide to what has been done and what remains to be done. This aspect is strengthened by the comprehensive bibliography of the subject which is included.

The earlier chapters, being an account of work done by others, are a bit stilted in places, and insufficient explanation is given of certain new concepts and symbols; but later the book becomes much more personal and stimulating. It is regretted that answers are not provided to the numerical questions in the sets of exercises which follow each chapter.

A possibly confusing misprint occurs on page 285, where γ appears as δ for half a page.

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FOR MATHEMATICIANS

Introduction to the Foundations of Mathematics. Raymond L. Wilder. New York: Wiley, 1952. xiv + 305 pp. $5.75.

PROFESSOR WILDER's book is based on courses of lectures designed to introduce modern ideas on the foundations of mathematics to pure mathematicians and to specialists in other fields whose work has a mathematical background. It will therefore have a wide appeal, and should prove interesting and instructive to anyone who has ever considered the problems underlying even the most elementary mathematics.

The book consists of two parts. The first is concerned with the material and methods involved in the foundations, and in the second there are descriptions of the various points of view as to the nature of mathematics. Chapters I and II are on the axiomatic approach, the second being devoted mainly to problems of consistency, independence and completeness of sets of axioms; the Law of the Excluded Middle is also discussed. There are several illustrations, some practical and some mathematical. The next three chapters are concerned with the theory of sets, the main emphasis being on infinite sets. The Russell contradiction is introduced at an early stage, and a section on the axiom of choice is included. Countability, the cardinal numbers, well-ordering and the ordinal numbers are all discussed in some detail. No mention is made here of the usual pitfalls in elementary mathematics associated with "infinity" and "infinitesimals." This is unfortunate, as a student suffering from the effects of haphazard teaching (which in this respect is all too common) should have the notions clarified before he starts a study of infinite sets. No doubt Professor Wilder's original students were well-trained, but other people likely to benefit from the book might not be. Chapter VI is on the real number system, and includes a discourse (leaving out many details) on the approach through Peano's axioms. Complex numbers are mentioned very briefly. The first part of the book ends with a chapter on algebra and geometry, including a section on topology. The approach to geometry is through Klein's Erlanger Program, though the author admits that this is now regarded as being inadequate. The definition given of projective geometry is not strictly correct. The transformations used are not, as stated, transformations of a plane, but only of portions of a plane.

The second part of the book begins with a chapter on the history of the foundations of mathematics. Mention is made of the parts played by such mathematicians as Kronecker, Cantor, Boole, Peano, Zermelo, and Poincaré. Then follow three chapters on three distinct schools of thought—the followers of Frege and Russell, the intuitionists, and the formalists. The author presents the different viewpoints in an unbiased manner, mentioning the advantages and disadvantages of each. The final chapter is entitled "The Cultural Setting of Mathematics." Here Wilder examines the position of mathematics in past and present civilizations. This is an interesting chapter, and it makes an excellent conclusion to a book which is rarely dull and frequently stimulating.

The style of writing is pleasing, and the author usually expresses himself clearly. There are several places, however, at which the reader may be misled. For example there is a vague definition on page 15 of the word "corollary," and an illustration is given; but many mathematicians would not call this a corollary, for the proof requires an additional axiom to those used in the proof of the theorem. On page 87, the theorem that the cardinal number of the plane is the same as that of the continuum does not seem to be proved correctly. The correspondence defined by the author does not relate the open unit interval to the open unit square, as he claims. A surprising statement (p. 4 and again on p. 271) is to the effect that Euclid's Elements are still used as textbooks in English schools. This may be true in isolated cases, but it is far from being a general rule. Geometry in English (or, more generally, British) schools is taught mainly from textbooks fashioned after Euclid's style.

The paragraphs and sections have been numbered by means of a decimal system which is much more complicated than is necessary, especially in a book of this kind. More annoying, however, are the footnotes, of which there are far too many. Some of them include quite important statements which might well have been incorporated in the main text. In any case, a superabundance of footnotes tends to make the reading uncomfortable.

However, these shortcomings are only on minor points. On the whole the book is well worth a careful

study, and it makes a pleasant contrast with the usual type of mathematical textbook. It is to be hoped that it will be used, as the author suggests, for courses similar to those he has given at the University of Michigan. The book could not be blamed if such a course did not precipitate much lively discussion.

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INNOVATIONS IN CALCULUS

Calculus, a Modern Approach. Karl Menger. Chicago: Illinois Institute of Technology, 1952. 255 pp.

THIS stimulating book is intended as a textbook in a beginning calculus course, a point of view which will arouse numerous cries of protest as well as a much smaller number of assents. It is the author's thesis that the conventional notation of calculus tends to obscure the essential ideas and make the subject excessively difficult for the beginning student. Professor Menger has systematically developed a notation for functions and their derivatives and integrals that he claims to be superior not only logically but also pedagogically. Whether or not his notational innovations will be accepted in their entirety seems to be doubtful, but certainly many of them are highly worthy of consideration by all teachers and writers. The book is recommended reading for teachers because of its unorthodox point of view and the freshness of its presentation. That the book is convenient to use as a textbook in an elementary class seems questionable but the reviewer is sympathetic with the author's aims and approach and would like very much to try it.

Some particular aspects of Professor Menger's notation are as follows. Instead of denoting a function by $f(x)$, as is common but logically incorrect as the symbol $f(x)$ denotes the value of the function at x, he uses merely the symbol f. The value of f at x then is denoted by fx. Similarly the derivative which is often denoted by $(d/dx)f(x)$ he denotes by Df, the other marks in the conventional symbol being superfluous. Likewise the conventional symbol $\int_a^b f(x)\,dx$ becomes merely $\int_a^b f$. In every case when dealing with functions as such, the symbol for the variable is omitted as being extraneous. This necessitates the introduction of certain new symbols for common functions, for example, the function whose value at x is equal to x is denoted by I and is called the identity function so that what is conventionally written $f(x) = x^3$ becomes $f = I^3$. These changes and others are logical consequences of the five principles of sound notation: (1) where it does not matter what we write, we write nothing at all; (2) what is derived for an arbitrary member of a class must be valid for any particular member; (3) in one sentence or equality the same symbol always has the same significance; (4) in every expression any symbol may be replaced by an equivalent symbol; (5) no unnecessary symbol should be created (Occam's razor), and all necessary ones must be.

As far as pure mathematics is concerned, Menger's innovations are natural and largely free from objection. It is in applications that difficulties appear. For example, if F is a force, then F may be either impulse or work, depending on whether F is regarded as a function of time or distance. This impasse led the author to introduce "descriptive" functions and "denominate" functions. The difficulty in physics, and in all applications, arises from insistence on the use of variables which often obscures the functional relationships involved. Doubtless, in the course of time, the majority of Professor Menger's notational changes will become standard, but only after education of a new generation of physicists and engineers who find the innovations natural. At the present time it is only in the more abstract parts of modern mathematics that one finds notation similar to his proposal. Professor Menger is to be congratulated for producing a stimulating book which should have a permanent effect on the teaching of elementary mathematics.

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PHILOSOPHICAL VIEWPOINT

An Introduction to Mathematical Thought. E. R. Stabler. Cambridge, Mass.: Addison-Wesley, 1953. xviii + 268 pp. $4.50.

A SOUND knowledge of high school algebra and geometry is all the mathematical background required for an understanding of this lucidly written and stimulating book, the nature and purpose of which are described by its author in the following words:

"The chief aim of the book is to provide a unified and substantial approach to the logical structure of mathematics, and to develop a corresponding philosophical point of view toward mathematical knowledge. This is carried out by emphasis both on postulational foundations and on the process of logical reasoning itself, together with applications to science and other fields of thought.

The presentation is introductory and exploratory in nature. It is not intended to supply a technical treatment either of logic, or of the foundations of mathematics."

The text is divided into two parts. In the first part the view that mathematical truths are not absolute but depend ultimately on the acceptance of postulates, definitions, and methods of reasoning is developed and supported by illustrations including Euclidean and non-Euclidean geometries and modulo arithmetics. An evaluation by modern standards of Euclid's elements and an assessment of the use of postulational organization in mathematical and non-mathematical fields is followed by an outline of those aspects of modern symbolic logic which pertain especially to mathematics.

This is followed by a discussion of scientific method, scientific theories, and the differences between scientific and mathematical truth.

The second part is considerably more advanced mathematically than the first. In it are developed, rigorously and at some length, important algebraic systems including groups, rings, fields, Boolean algebras, lattices, and also a finite geometry. Some of these are used to illustrate such properties of sets of postulates as consistency, independence, completeness, weakness, and categoricalness. The postulational systems of Hilbert, Huntington, and Peano, concerning, respectively, Euclidean geometry, complex numbers, and natural numbers are discussed, though not in full detail. There is also a brief description of the Whitehead-Russell, formalist and intuitionist approaches to the foundations of mathematics.

The text, which includes numerous exercises, is arranged and presented so as to make it possible to base various types of courses, with different levels of difficulty, on selected chapters, or sections within chapters. Schemes for general education courses, background courses for prospective teachers of secondary school mathematics, and introductory courses for specialists in pure mathematics are suggested by the author.

On the whole, this book gives an excellent and reasonably comprehensive yet elementary account of axiomatics and axiomatic systems. The author, however, does not attempt more than a cursory discussion of the role of definition and construction in the development of mathematics; for an adequate treatment of such topics as the Dedekind (or Cantor) definition of real numbers and, more generally, the foundations of analysis, he refers the reader to appropriate sources of information.

A bibliography lists all books and articles referred to in the text and some selected additional references.

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BRIEFLY REVIEWED

Possums. Carl G. Hartmann. Austin: University of Texas Press, 1952. x + 174 pp. Illus. $6.00.

THIS is the kind of book which can only be written by an able observer who has studied his subject over a long period of time, and who is literate and humorous as well as learned. Its essence is best summarized in a quotation from the end of Chapter Five: "In this chapter I have more or less taken the animal apart for closer analysis—which is one way of studying an animal. . . . I am not unmindful, however, of the oneness of a living organism and the advantages of studying a representative of a species of animal as a whole. . . ." The result is an absorbing account of "what manner of beast" the possum really is.

Essentially it is a series of essays on various aspects of possums. We are introduced to them, as the European community was, through the descriptions and pictures of the early sixteenth century. The wealth of legend and folklore that existed then and still exists today is thoroughly and entertainingly explored. A chapter on taxonomy is followed by a discussion of the possum's physical characteristics. Its habitat and behavior, both legendary and real, are discussed. Quite a large section of the book is devoted to the author's special field, reproduction. The scope of the work is, however, far wider than this summary would imply. The amount and variety of historical and comparative material included make most of the chapters of very general interest. The reader learns much about the early naturalists and is furnished with many a shrewd and wise comment on the history and procedures of animal observation and investigation. Each chapter is, in a sense, complete in itself. This has led to a certain amount of repetition, particularly of historical data, but in no way to detract from the value of the book as a whole. It also makes for a certain unevenness, depending on what is known about a chosen topic and on how much the author himself has explored it in detail. Thus, in the chapter on "playing possum," the comparisons of related phenomena are fascinating but one could wish to know more of the actual processes involved. The excellent photographs and reproductions of early plates with which the book is liberally illustrated add greatly to its interest and value. A fairly extensive bibliography seems somewhat less critically chosen.

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The Human Senses. Frank A. Geldard. + 365 pp. Illus. $5.00. New York: Wiley. 1953.

FROM his extensive experience in psychophysiology, Professor Geldard has drawn together into a single compact volume a remarkably unified presentation of man's senses. Almost half of the book deals with vision and hearing; the remainder covers the many senses in the skin, kinesthetic and organic sensibilities, functions of the labyrinth, smell, and taste. In each instance the nature of the stimulus is considered, the type of receptors involved, methods of measurement in each specialized field, thresholds, differential abilities, effects of mixtures, electrophysiological approaches, and theories relevant to the subject. Reference is made throughout to a carefully selected bibliography of 330 entries. Stress is placed on the importance of the senses in human engineering, particularly in reference to Air Force problems in World War II. As a result, the book is both wonderfully informative and interesting reading.

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Methods and Principles of Systematic Zoology. Ernst Mayr, E. Gorton Linsley, and Robert L. Usinger. New York–London: McGraw-Hill, 1953. 328 pp. Illus. $6.00.

SYSTEMATICS is the branch of zoology (or botany) concerned with classification, especially the classification of individual species and genera. This work in systematics is conducted according to a rather rigid set of rules, whose interpretation and application often require the talents of a Philadelphia lawyer. It is this aspect of systematics, the restricted field of taxonomic (i.e., nomenclatural) procedure, that often irritates the bystander, to whom it appears to be a pointless game of name-changing. Although this book is intended for students and practitioners of systematics, it should also be welcomed by such innocent bystanders, who ought to consult it before penning an indignant letter to SCIENCE when some familiar name has been changed "for no apparent reason."

The broader aspects of systematics are far more interesting, and deserve to be more widely known. One of the most useful chapters of this book is that concerned with quantitative methods; together with the chapters on taxonomic characters and their discrimination it makes up the heart of the book. While this "manual of taxonomy" comes no nearer to defining a species than did Darwin, it does show what sort of information may be extracted from adequate samples or collections and indicates that taxonomy may be returning to favor in our graduate schools after a whilom absence from felicity.

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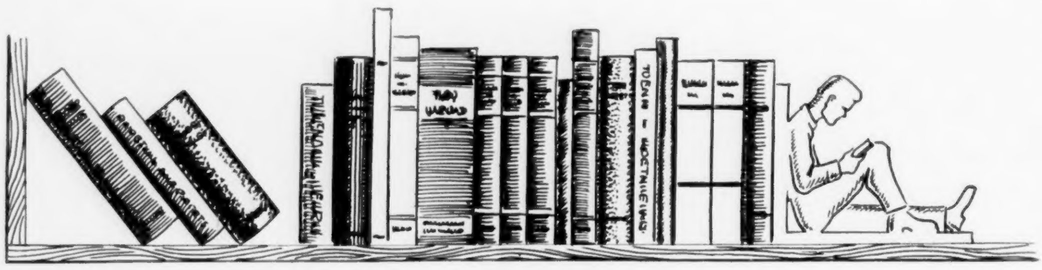

LETTERS

THE EDUCATORS' DEBATE

It was a pleasure to read Professor Trow's moderate article on education (Scientific Monthly, **76**, 149 [1953]). The constructive approach, and avoidance of a negative attitude, are most welcome in this controversial field! I do wish, however, that he had disposed of "Bestor's questionnaires" more adequately, applying the same constructive approach here as in the rest of the article. Clearly, he doesn't regard the questionnaires as characteristic: "Isn't it a rather dubious procedure to select two studies . . . and imply that they are typical? . . . The selection of data to fit one's thesis, with the neglect or suppression of contrary data, is a practice I am sure neither of you would follow in your own disciplines. Why do it when you step out of your field? . . ." I agree fully, but can't help feeling that this is negative criticism of Bestor's argument; it is not constructive.

What do I mean by a "constructive approach," in this connection? I mean simply exhibiting some widely circulated questionnaires, sponsored by professional educators, in which the intellectual disciplines receive the weight which is their due. I supposed all along that educators would disapprove of the emphasis in the Illinois study, just as other scholars do, and this expectation is confirmed by Professor Trow's article. The following is perhaps the sort of questionnaire that Professor Bestor would like to see—and Professor Trow, too, if one may extrapolate from his disapproval of the other. Such a poll, sponsored by educators, would give convincing evidence that the Illinois affair is really nontypical.—To get to the point: Could Professor Trow describe some questionnaires of the following sort that have been circulated by his profession? And what was the public response?

1. Are students taught to handle English well, in their writing and speech?
2. Should they be?
3. Are they encouraged to develop a good vocabulary?
4. Does the public school give its students a sound knowledge of American literature?
5. Of English literature?
6. Does it enable them to enjoy and appreciate such literature?
7. Is public school education in French (or other modern languages) adequate for the needs of one traveling abroad?
8. Does it give any significant acquaintance with good French (or other foreign) literature?
9. On the whole, do you consider instruction in handwriting better now than it was thirty years ago?
10. Spelling?
11. Reading?
12. Arithmetic?
13. Geography?
14. Grammar?
15. History?
16. Is the American history now taught adequate for present-day requirements of good citizenship?
17. Same, foreign history?
18. Does the school give its students a good understanding of the great ancient civilizations?
19. Should it?
20. Does the school help the student to know and enjoy good music?
21. Same, art?
22. Generally speaking, would you say that instruction in high school mathematics (algebra, geometry, trigonometry) is as good here as in England (or Germany, or France)?
23. Is an acquaintance with the exact sciences desirable for citizens of the present day?
24. Do most students obtain a fair knowledge of chemistry before leaving high school?
25. Of physics?
26. Of mathematics?
27. Does the present educational system develop the ability to concentrate and study effectively?
28. To analyze complex intellectual situations?
29. Are these abilities important in the modern world?
30. Do the schools make a serious effort to discover and develop our more gifted children?
31. Do students of elementary schools, in general, get as much "intellectual fare" as they should?
32. Same, high school?
33. Does the psychological atmosphere of our schools foster a respect for intellectual pursuits?

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This letter concerns the article by Dr. Trow in the March 1953 issue of The Scientific Monthly. I doff my hat to him as a shrewd debater, but I do not find any plain refutations of the charges of Bestor and Fuller. He instead relies, in the first instance, upon attempts of defamation of character, and his use of the attack oblique is worthy of study. For example, in the third paragraph, he links Prof. Bestor with those "attacking the public school—seeking to destroy it." Not a direct accusation but a supposedly clever casting of doubt upon Prof. Bestor's motives. Instead of impugning motives, Dr. Trow's letter would be much more effective if he had, if possible, cited facts to negate the exhibits quoted by Prof. Bestor.

The case is understated in the fifth paragraph. Sometimes it seems the "educators" (such as our Regents in Albany) have their heads so far in the clouds that they have entirely forgotten the basic processes of teaching and learning.

It is quite true there are incompetents in theory and practice in other fields but they are soon recognized as such. A teacher in engineering, say, cannot hide very long an ignorance of the fundamental principles and their application. An engineer or a doctor or a mason or a carpenter soon has his ability assessed by colleagues and public and receives his reward in proportion. But a professor of education or a state school system under control of these "progressive" (?) educators is not readily accessible to the public, which in truth, pays for both. The deterious effects of the progressive system are beginning to be seen now. They have been increasing rapidly the past five years or so, but the public opinion is a slow maturing thing and the damage will continue until the public will becomes vociferous enough to bring back to our schools the ideas of intellectual disciplines so badly needed. Bestor, Fuller, Lynd are the prophets going before, and the progressive educators would do well to check their retirement income plans.

We readily concede the first of your "facts." The second can be amplified to point out that genuine education would seem to have as only one part of it, "intellectual training." It also has "physical training" and "moral training." It would seem also that the school is primarily concerned with the intellectual part of this training; it may be involved in the other two as being parts of the "whole man" but these should be incidental, not major, parts of the school program, and subordinate in every way in the normal school to the "intellectual" concern.

Trow's profound statement that half the people in the world are below average in intelligence, coupled with his subsequent remarks, insinuates that these people could be taught how to control a 200 H.P. automobile even though they could not necessarily add up a grocery bill. No wonder the accident rate and insurance rates continue to climb! It is not the purpose of the schools to train young people to meet "life" problems. These are probems of the home and the church. Our schools are set up, as our pioneer schools were, to teach children reading, writing, and arithmetic. Their results along these lines have been increasingly worse, particularly in recent years under the guidance of "progressive" educators. And until they can show themselves capable of training children in the basic skills, they should not be allowed to dabble in the high-sounding "meeting life" theories.

As for interpreting results, we may point to the yearly college aptitude tests. We claim to select our students from the top fifth. This appears fine but the joker is that the educators who run these tests apparently are not able to (or do not wish to) correlate the tests year by year. Consequently, it has been freely admitted that this top fifth is progressively poorer each year. The result is a demand that the colleges should reduce their entrance requirements, that students should be led more easily into the rigor of college work. Our colleges did not, at one time, have to offer remedial reading courses; now more than half of our freshmen need them and we wish such courses could be made "required." And why is it that matriculants have so little knowledge of what "study" means? Why is it that so many of them cannot write a sentence without a mistake in syntax or grammar or spelling? Our schools proclaim "self-expression" for the children; when do they learn to express themselves in speech and writing? Surely "self-expression" has no connection with untrammelled freedom of action.

Instead of the clever fending Trow indulges in, let us have some straight answers to these straight questions. If the public school educators cannot think of an out, let us get our schools back to the "intellectual training" so lightly regarded by Dr. Trow. Then when the faults implied in these questions are corrected, then only let the educators, by express consent of the parents and taxpayers, indulge in courses in basket-weaving, auto-driving and enriched verbiage.

P. D. TUTTLE

School of Electrical Engineering
Cornell University

ON first reading Professor Tuttle's letter, I did not think he could be serious, but a re-reading made me think that perhaps he was not indulging in a satirical piece after all. If he is serious, his statements are so fantastic and so emotionally charged that they hardly call for reply, though I would be glad to comment on them specifically should he so desire.

I do wish to clarify two points however. The first is that I had no intention of engaging in the "guilt by association" technique, but instead I wanted to point out the unfortunate fact that those who are actual enemies of the public schools do use some of the less carefully guarded statements of those who are not.

The second relates to his statements beginning: "It is not the purpose of the schools. . . . Our schools are set up. . . ." These, of course, are not statements of fact but of Professor Tuttle's opinion. Fortunately there are many other equally competent people who hold different opinions.

PROFESSOR REDHEFFER's suggested questions reveal that he recognizes some of the complexities involved in the problem of adopting the school program to the needs of the children and of the culture. It would be advantageous if we knew the answers to some of his questions, many of which would be helpful in aiding a particular school in evaluating its own program.

But the questions would be difficult to answer for schools in general partly because of the wide diversity in practice, and partly because many of the questions call for factual answers rather than opinions. For example, citizens generally have no basis for answering questions as to whether instruction in arithmetic or any other subject in American schools is "adequate," or whether it is better than it was thirty years ago. One could find out how many students take chemistry in high school, but how do the school patrons decide what is "a fair knowledge" of chemistry?

Those interested in the problem of the use of public opinion surveys in improving instruction (and I hope Professor Tuttle and other Bestor protagonists will do so before engaging in further public controversy) should send to the National Association of Secondary School Principals (1201 Sixteenth St., N.W., Washington 6, D. C.) for the *Bulletin* entitled, "A Scholar's Documents," by Professors Harold C. Hand and Charles W. Sanford. This bulletin, among other matters deals with Professor Redheffer's inquiry about questionnaire studies. It points out (pp. 476–477) that whereas Professor Bestor referred only to the so-called "Follow-up Study," of the holding power of the high schools, he made no mention of six other studies which are also in progress in Illinois. One of these is the series called "The Local Area Consensus Studies." These latter consist of twenty "local action projects . . . one for each subject. . . . Among these subject fields are art, English, foreign languages, mathematics, music, science, and social studies." Quoting further from the bulletin: Each of these questionnaire and interview studies "is or will be designed to enable local patrons, teachers, and older pupils to consider the following three things:

(1) What the purposes or objectives of the subject or service in question should be in the local high school.

(2) Which of these desired purposes are, and which are not, currently being achieved to an adequate degree.

(3) What should be done in the local high school to accomplish those of the desired purposes which are not being adequately achieved."

The Hand and Sanford bulletin goes on to show how the materials for these local studies are constructed taking mathematics as an example. Such studies as these are indicative of one kind of approach to the question raised by Professor Redheffer. There are, of course, others.

Wm. Clark Trow

School of Education
University of Michigan

LIBERALISM VS. LIBERALISM

From time to time over the last two years you have published articles by members of the faculty of the University of Illinois on matters of educational policy in the elementary and secondary schools. It appears that the current controversy over liberalism vs. traditionalism in American education has reached a level of bitterness in Illinois which most other sections of the country have thus far avoided.

One need not object to emotionalism in argument to disapprove the inclusion of such argument in the official magazine of American science. Whatever the merits of the issue, Messrs. Fuller, Bestor, and now Cairns do themselves no credit as scientists in the utterances of theirs which you have published.

I assume we are agreed that dispassionate inquiry into any area of intellectual interest is the very keystone of the scientific method. A dispassionate evaluation of the writings of the gentlemen to whom reference is made will, I believe, reveal little of the scientist's balanced unemotionalism in their theses.

As a scientist and educator I protest the inclusion in The Scientific Monthly of genuinely unscientific material.

Irving C. Whittemore

Washington, D. C.

A TUTELO CHIEF JOINS HIS ANCESTORS

The March issue of Scientific Monthly brought an article on the Tutelo Harvest Rite, which had been recorded by Chief Peter Buck. As a dramatic sequel the author received the following notice:

March 18, 1953

Dear Friend,

With extreme sorrow we inform you of the passing of my father, Chief Peter Buck, after a short illness. He died on Sunday March 15th at the age of 71 years. Was laid to rest at Onondagas on Tuesday March 17th.

We are sorry we were unable to let you know sooner.

Sincerely
Roy Buck and Family
and
Mrs. Eliza Buck

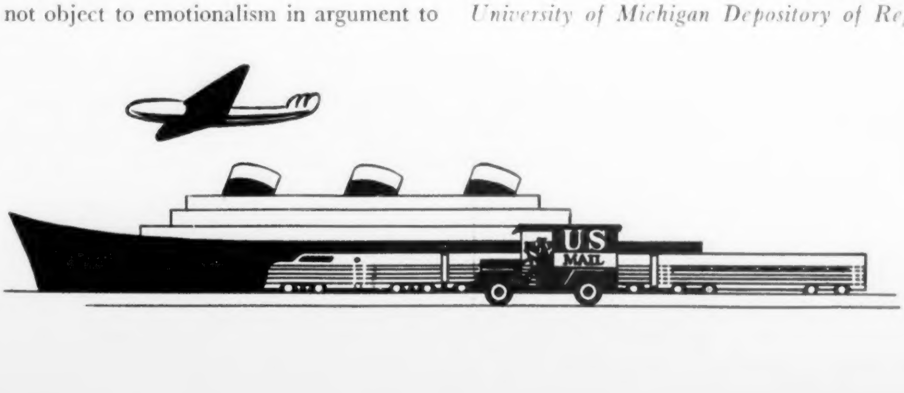
Two days later a letter from a close relative of his included a confirmation, " . . . and he passed away on Sunday morning on 15th. It's a real loss to our longhouse, he knew so many sacred songs. So we'll have a dress up dance, all-night feast for him on Tuesday, Tutelo rites. Too bad you cannot be here."

A conservative ritualist, Peter Buck confined his singing to the actual rituals. He recorded sparingly, after three years of gentle persuasion, in his last summer. Posthumously his relatives desire disc copies of his traditional Four Nights Dance and Individual Chants.

His vigorous, kindly personality and strong lean features bring to mind William Byrd's impression of the Southern Sioux of 250 years ago, as "the most honest and brave Indians the Virginians had ever known."

Gertrude P. Kurath

University of Michigan Depository of Regional Music



ASSOCIATION AFFAIRS

HOTEL HEADQUARTERS, SEVENTH BOSTON MEETING, DECEMBER 26–31, 1953

THE preliminary announcement of the Seventh Boston Meeting of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (SCIENCE, **117**, 613 [1953]; THE SCIENTIFIC MONTHLY, **76**, 315 [1953]), which was principally concerned with the programs of this year's 120th Meeting, named the headquarters hotels of the AAAS and the zoological societies (Statler), of the geneticists (Sheraton Plaza), and of the science teaching societies (Bradford). The detailed list of the headquarters hotels of all participating societies and of each AAAS section was scheduled to appear at this time when data on hotel rates could also be announced.

As in recent years, the center of the Association's annual meeting is a large convention hall—this year, the Mechanics Building—which houses the Main Registration-Information Center, the Visible Directory of Registrants, the Annual Exposition of Science and Industry, the AAAS Office, and the AAAS Science Theatre. In this building will be held the two general symposia of the Association, nearly all of the programs of the 18 sections of the Association—e.g., physics, chemistry, geology and geography, botany, psychology, the social sciences, engineering, and medical sciences (including medicine, dentistry, and pharmacy)—the illustrated lecture of the National Geographic Society, important conferences on scientific editorial problems and scientific manpower, and the Biologists' Smoker.

As usual, the sessions of the participating societies, principally, will be in four hotels chosen for their adequacy and relative convenience to the Mechanics Building, which is at 111 Huntington Avenue, two blocks west of Copley Square. The basic pattern of the session arrangements for the participating societies is the logical one of grouping specialists and closely related organizations in the same hotel to ensure maximum convenience for those attending concurrent sessions and similar programs. With respect to housing, the additional hotels named are close to those designated as headquarters. All hotels are listed by *zones*: Hotels of the Copley Square area are close to Mechanics Building; of the hotels which are downtown, the Statler is three blocks east of Copley Square, the Bradford and Touraine two blocks further; in a northwest direction, the Somerset and Kenmore in Back Bay are a shorter distance from Mechanics Building. By underground trolleys along Boylston Street, no one is more than 5 to 10 minutes from meeting rooms in Mechanics Building or from the extremes of these hotels.

The hotels of Boston have agreed to provide ample housing at moderate rates. Housing will be handled by the well-directed and efficient Boston Convention Bureau. Hotel room assignment-confirmation slips are typed in quadruplicate, and one of these will be sent directly to the applicant. Those who apply early are assured the hotel of their first choice, but it must be remembered that the supply of single rooms at minimum rates is always relatively limited—it pays to apply early for them. Higher priced singles and double rooms for single occupancy are more plentiful. It is desirable that ***maximum rate*** be stated, as well as desired rate, on application forms. Expenses can always be reduced if rooms or suites are shared with one or more colleagues or friends. Special attention is called to dormitory accommodations—3 to 5 comfortable rollaway beds in a large room with private bath—at \$2.75 to \$3.00 per person per night.

Beginning with this issue, the advertising section of THE SCIENTIFIC MONTHLY will carry page announcements of the hotels and their current rate schedules, together with a coupon which should be filled out and sent, ***not to a hotel***, but to the AAAS Housing Bureau in Boston. Applications for hotel reservations will be filled in the order of their receipt.

Individuals of course have freedom of choice of hotels, but, in stating their preference, the desired rate and the maximum rate, it is natural that those who apply latest may not secure their first choice of hotels. Usually a person's preference is for the hotel that has been named as headquarters for his section or society, but the hotels in the same zone are nearby. For the convenience of those planning to attend the 120th Meeting of the Association, the headquarters for the 18 sections and subsections and the participating societies are listed here:

Hotel Headquarters

Downtown Zone

Statler
(1,300 rooms)
Park Square

AAAS; Press; AAAS Sections C, F, I, Nm, Nd, Np; Alpha Chi Sigma; American Society of Zoologists, Herpetologists League, Massachusetts Zoological Society, Society for the Study of Evolution, Society of Systematic Zoology; Alpha Epsilon Delta, American Association of Hospital Consultants, American Institute of Nutrition, American Physiological Society; American Association of Colleges of Pharmacy, American College of Apothecaries, American Drug Manufacturers Association, American Pharmaceutical Manufacturers Association, American Pharmaceutical Association, American Society of Hospital Pharmacists; American Book Publishers Council, American Textbook Publishers Institute, Conference on Scientific Editorial Problems, National Association of Science Writers, Scientific Research Society of America, Society of the Sigma Xi, United Chapters of Phi Beta Kappa

Bradford
(400 rooms)
275 Tremont St.

Academy Conference; AAAS Cooperative Committee on the Teaching of Science and Mathematics; AAAS Section Q; National Speleological Society; American Nature Study Society, National Association of Biology Teachers, National Science Teachers Association.

Touraine
(200 rooms)
62 Boylston St.

Parker House
(700 rooms)
60 School St.

Copley Square Zone

Sheraton Plaza
(500 rooms)
Copley Square

AAAS Sections G, H, L, O; American Eugenics Society, American Society of Human Genetics, American Society of Naturalists, Beta Beta Beta, Ecological Society of America, Genetics Society of America; American Society of Plant Physiologists, New England Section; History of Science Society, Institute for the Unity of Science, Philosophy of Science Association.

Copley Square
(124 rooms)
47 Huntington Ave.

Lenox
(175 rooms)
61 Exeter St.

Vendome
(300 rooms)
160 Commonwealth Ave.

Back Bay Zone

Somerset
(500 rooms)
400 Commonwealth Ave.

AAAS Sections A, B, D, E, K, M, P; American Meteorological Society; Association of American Geographers, Geological Society of America, National Geographic Society; National Academy of Economics and Political Science, Pi Gamma Mu; American Industrial Hygiene Association, Society for Industrial Microbiology; American Geophysical Union, Conference on Scientific Manpower.

Kenmore
(400 rooms)
490 Commonwealth Ave.

Advance Registration and Advance Copies of the General Program-Directory

As in past years, those who plan to attend the meeting may register in advance and receive both a Convention Badge and a copy of the General Program-Directory, by first-class mail, early in December. The registration fee of $2.50 includes postage. Those who cannot attend the meeting but would like an advance copy of the General Program-Directory may also obtain it by first-class mail early in December at cost—$1.50. A coupon covering both alternatives will be found on another page in the advertising portion of this issue of THE SCIENTIFIC MONTHLY. The appropriate square should be checked.

Sectional Sessions for Contributed Papers

Another section of the Association—Section L—has requested the publication of a call for contributed papers. The following is a complete list of the 10 AAAS sections which will receive short papers on current research. In general, a brief abstract should accompany each title and these should be sent each section secretary or program chairman, *not later than September 30*—preferably earlier.

C, Chemistry—Dr. Ed. F. Degering, George Washington Inn, New Jersey and C Streets, S.E., Washington, D. C.

E, Geology and Geography—Dr. Jack B. Graham, 3400 North Westmoreland Street, Falls Church, Va.

G, Botanical Sciences—Dr. Stanley A. Cain, School of Natural Resources, University of Michigan, Ann Arbor, Mich.

H, Anthropology—Dr. Gabriel Lasker, Wayne University, 1512 St. Antoine Street, Detroit 26, Mich.

I, Psychology—Dr. William D. Neff, Department of Psychology, University of Chicago, Chicago 37, Ill.

L, History and Philosophy of Science—Dr. Raymond J. Seeger, 4507 Wetherill Rd., Washington 16, D. C.

Nd, Dentistry—Dr. Russell W. Bunting, School of Dentistry, University of Michigan, Ann Arbor, Mich.

Np, Pharmacy—Dr. George F. Archambault, Pharmacy Branch, Division of Hospitals, Federal Security Agency, Public Health Service, Washington 25, D. C.

O, Agriculture—Dr. C. E. Millar, Department of Soil Science, Michigan State College, East Lansing, Mich.

Q, Education—Dr. D. A. Worcester, University of Nebraska, Lincoln, Neb.

RAYMOND L. TAYLOR
Associate Administrative Secretary, AAAS

THE *Theobold Smith Award* of $1000 and a bronze medal, sponsored by the Eli Lilly Company of Indianapolis under the auspices of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, will be given for the ninth time at the Boston meeting in December. The prize is given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." Nominations should be sent to Allan D. Bass, Department of Pharmacology, Vanderbilt University School of Medicine, Nashville, Tennessee, before September 15. They should be in triplicate and accompanied by full information concerning the nominee's personality, training, and research work. U. S. citizens less than 35 years of age on Jan. 1, 1953, are eligible. Nominations may be made by AAAS Fellows, and the Vice President for Section N, Medical Science, and four Fellows of the Section will form the committee of award. The last winner was Frank J. Dixon, Jr., of the University of Pittsburgh School of Medicine, for a paper entitled "The Dynamics of Immune Response."

Meetings

July 30–Aug. 1. Wyoming Geological Association. University of Wyoming, Field Conference. Laramie.
Aug. 3–5. Abnormal and Pathological Plant Growth. Brookhaven National Laboratory, Upton, L. I., N. Y.
Aug. 3–8. Photographic Society of America. Los Angeles, Calif.
Aug. 3–8. World Meteorological Organization, Regional Assoc. for North and Central America, First Session. Toronto, Canada.
Aug. 5. Symposium on Macromolecules. Uppsala, Sweden.
Aug. 5–12. International Congress of Zoology. Copenhagen.
Aug. 7–8. Pennsylvania Academy of Science (Summer). Thiel College, Greenville, Pa.
Aug. 9. International Veterinary Congress (15th). Stockholm.
Aug. 10–14. Society of American Bacteriologists (Annual). San Francisco.
Aug. 10–18. American Association of Colleges of Pharmacy (Annual). Salt Lake City, Utah.
Aug. 15–30. Summer Seminar-Workshop in General Semantics (10th). Institute of General Semantics, Lakeville, Conn.
Aug. 16–22. American Pharmaceutical Association. Salt Lake City.
Aug. 16–26. International Conference on Soil Mechanics and Foundation Engineering (3rd). Zurich and Lausanne, Switzerland.
Aug. 17–19. Society of Automotive Engineers (International West Coast Meeting), Georgia Hotel, Vancouver, B. C.
Aug. 18–21. American Institute of Electrical Engineers (Pacific General). Vancouver, B. C.
Aug. 18–21. International Union of Biological Sciences (11th General Assembly). Nice, France.
Aug. 19–21. Wescon (Western Electronic Show and Convention), jointly sponsored by IRE (7th Region) and WCEMA (West Coast Electronic Mfgrs. Assoc.) Municipal Auditorium, San Francisco.
Aug. 20–26. Congrès International de Philosophie. Brussels.
Aug. 20–30. International Congress of Limnology (12th). Cambridge, England.
Aug. 22–25. Joint Commission on High Altitude Research Stations. Boulder, Colo.
Aug. 23–28. American Dietetic Association. Los Angeles, Calif.
Aug. 24–28. International Congress of Rheumatic Diseases. Geneva, Switzerland.
Aug. 24–29. Oak Ridge Summer Symposium (5th Annual). Oak Ridge, Tenn.
Aug. 24–29. World Conference on Medical Education (1st). London.
Aug. 24–31. International Genetics Congress. Bellagio, Italy.
Aug. 26–28. American Mathematical Society (Sixth Symposium in Applied Mathematics). Corona, Calif.
Aug. 26–28. Gerontological Society, Inc. (Annual). San Francisco.
Aug. 28–Sept. 4. International Congress on Tropical Medicine and Malaria. Istanbul, Turkey.
Aug. 30. International Association for Hydraulic Research. Minneapolis, Minn.
Aug. 30–Sept. 1. American Sociological Society (Annual). University of California, Berkeley.
Aug. 30–Sept. 3. International Society of Orthopedics and Traumatology (6th Congress). Bern, Switzerland.
Aug. 31–Sept. 3. American Hospital Association. San Francisco.
Aug. 31–Sept. 4. International Congress of Physiology (Triennial). Montreal.
Aug. 31–Sept. 4. International Physiological Congress. Montreal.
Aug. 31–Sept. 5. American Mathematical Society, Mathematical Association of America, and Canadian Mathematical Congress. Queen's University and Royal Military College, Kingston, Ont., Canada.
Sept. 1–3. Fourth Symposium on Plasticity. Brown University, Providence, R. I.
Sept. 2–9. British Association for the Advancement of Science (Annual). Liverpool.
Sept. 4–9. Psychometric Society (Annual). Michigan State College, Lansing.
Sept. 6–10. American Institute of Biological Sciences. (Annual). University of Wisconsin, Madison.
Sept. 6–10. The Nature Conservancy (with AIBS). Madison, Wis.
Sept. 6–11. American Chemical Society (124th National). Chicago.
Sept. 6–12. Congresso Internazionale di Microbiologia. Rome.
Sept. 8–10. American Society of Limnology and Oceanography (Eastern Section). University of Wisconsin, Madison.
Sept. 9–15. American Meteorological Society, Royal Meteorological Society, Toronto.
Sept. 13–16. Electrochemical Society, Inc. Ocean Terrace Hotel, Wrightsville Beach, N. C.
Sept. 14–17. Illuminating Engineering Society. Commodore Hotel, New York.
Sept. 14–17. Society of American Foresters. Colorado Springs, Colo.
Sept. 14–24. International Instrument Congress and Exposition. Philadelphia.
Sept. 18–27. Congress of the International Scientific Film Association (7th). London.
Sept. 23. American Medical Writers' Association (Annual). Elks' Club, Springfield, Ill.
Sept. 27. American College of Dentists (Annual). Cleveland.
Sept. 28–Oct. 1. American Dental Association (Annual). Cleveland.
Sept. 28–Oct. 3. Alaskan Science Conference. Juneau.
Oct. 3–10. Sixth International Congress of Leprosy. Madrid, Spain.
Oct. 8–9. American Council on Education (Annual). Hotel Statler, Washington, D. C.
Oct. 10–16. American Academy of Ophthalmology and Otolaryngology (Annual). Palmer House, Chicago.
Oct. 15–17. Acoustical Society of America (Annual). Cleveland, Ohio.
Oct. 19–21. Entomological Societies of Canada and British Columbia (Annual, Joint Meeting). Empress Hotel, Victoria, B. C.
Oct. 30–31. Kentucky Academy of Science (Fall). University of Kentucky, Lexington.